SOLID WASTE MANAGEMENT COST ACCOUNTING SYSTEM PILOT IMPLEMENTATION

OCTOBER 1979

Waste
Management
Advisory Board

PILOT IMPLEMENTATION OF THE SOLID WASTE MANAGEMENT COST ACCOUNTING SYSTEM

Prepared for the
Waste Management Advisory Board
by
Currie, Coopers & Lybrand Ltd.

October 1979

WASTE MANAGEMENT ADVISORY BOARD

TABLE OF CONTENTS

		Page No.
I.	INTRODUCTION	1
II.	ASSESSMENT OF SYSTEM PRACTICALITY, BENEFIT AND COST WERE KEY OBJECTIVES	4
III.	PARTICIPATION WAS GOOD AND COMPREHENSIVE DATA WAS DERIVED FOR ASSESSMENT	5
	A. MUNICIPALITIES PARTICIPATED WILLINGLY WITH VARYING DEGREES OF COMPLETENESS OF DATA FORMS	5
	B. A BRIEF ANALYSIS OF THE PROVINCIAL "PILOT" REPORT INDICATES THE EFFECTIVENESS OF COMPARATIVE MANAGEMENT COST INFORMATION	11
	C. SOLID WASTE DENSITY FACTORS ARE NOW AVAILABLE FOR INTERIM USE	27
	D. A WEIGHT ESTIMATING PROCEDURE AND A TRUCK COUNTING PROGRAM WAS INITIATED	41
	E. AN INTERIM COMPUTERIZED PROVINCIAL REPORTING SYSTEM IS NOW AVAILABLE AND CAN BE MODIFIED FOLLOWING WIDER IMPLEMENTATION	51
	F. WASTE MANAGEMENT BRANCH STAFF CAN IMPLEMENT THE COSTING SYSTEM ON A WIDER SCALE	53
IV.	WIDE SCALE IMPLEMENTATION OF THE COSTING SYSTEM WILL BE PRACTICAL AND BENEFICIAL	54
	A. MUNICIPALITIES CAN MEASURE THEIR COMPARATIVE PERFORMANCE	55
	B. DATA AVAILABLE TO THE PROVINCE AND THE POLICY MAKERS WILL BE ENHANCED SUBSTANTIALLY	56
V.	IMPLEMENTATION IN 148 MUNICIPALITIES IS PRACTICAL FOR 1979 DATA	58
VI.	CONCLUSION	61

I. INTRODUCTION

Currie, Coopers and Lybrand Ltd. is pleased to submit this report to the Ontario Waste Management Advisory Board and the Ministry of the Environment on the pilot implementation of a Solid Waste Management cost accounting system for the Province of Ontario. Municipal solid waste collection and disposal costs in the province totalled $109 million in 1977. This assignment was undertaken to test the practicality of introducing a standardized provincial reporting system to improve control over these costs and provide added information for the evaluation of policy options in the management of solid waste.

The pilot implementation study was undertaken by Mr. B. Wolfman, partner, and Mr. A. F. Johnstone, senior consultant, who worked closely with the Ministry's Waste Management Branch personnel and staff from the participating municipalities. The assignment commenced in January 1979, pursuant to the terms of reference attached as Appendix I to this report, and originally set out as part of our February 28, 1978 report to the Board on the design of the solid waste costing system.

This report sets out the key steps taken to test the prototype costing system on a pilot implementation basis, describes our suggestions for the ongoing refinement of the system, and recommends future wider scale implementation within the Province of Ontario. In brief the report covers the following points:

- Organization of the assignment working with Waste Management Branch staff and municipal staff,
- Development of solid waste density factors for use by weighing and non-weighing municipalities,
- Introduction of truck counting procedures in non-weighing municipalities,
- Details of the work carried out with nine municipalities to obtain solid waste cost and operating information,

- Evaluation of municipal co-operation,

- The preparation of provincial monitoring reports both manually and by the adaptation of a computer reporting system,

- A review of the usefulness of the data provided by the provincial reports, and

- An assessment of the benefits to both the municipalities and provincial policy making bodies of adopting the system on a wider scale.

To date the pilot implementation program has provided the following key indications of solid waste generation and cost for the nine sample municipalities.

- Residential solid waste generated annually averaged 714 pounds per capita in the four sample municipalities that operated collection services and had weighing facilities.

- Total solid waste generated annually in two of the above municipalities that also operated disposal services was 1,584 pounds per capita.

- Collection cost per ton for six sample municipalities ranged from $15.67 to $39.04 and averaged $30.18 per ton. The differences in cost per ton are attributable to size of municipality, the nature of operations, the service levels provided, and varying levels of municipal efficiency.

- Disposal cost per ton for six sample municipalities ranged from $3.60 to $12.27 and averaged $8.43. Differences in cost per ton are due to travel distances, the size and sophistication of disposal operations and the varying levels of municipal efficiency.

After study of the detailed collection cost statistics for five sample municipalities and general cost statistics for 102 other Ontario municipalities with a population of over 10,000 people, it is evident that substantial cost savings may be achievable over a period of time. The savings would be made if the municipalities with above average costs could gradually reduce these costs to the average level, by implementing some of the efficiencies achieved in the lower cost communities. The total potential savings for collection costs are estimated at $3.6 million per annum.

Similar estimates of potential savings have been made for landfill costs using data from four sample municipalities, which has been applied to general cost statistics for an additional 69 municipalities with disposal operations and populations in excess of 10,000. In this case potential savings of $2.9 million per annum may be achievable over a period of years. Achievement of the above savings would require changes in operating performance and service level for the higher cost communities so that they would fall in line with average experience.

One further area where estimates have been made is in regard to municipal revenues. If sufficient charges were made to all private users to fully cover the disposal cost per ton actually incurred, an increase of $3.2 million in revenue would be achieved.

Although changes in municipal operating practices and revenue policies would take several years to introduce, the potential gains to municipalities in the Province could be substantial and could approach a 10% reduction in net solid waste management costs. This cost reduction is more likely to occur if the cost accounting system reviewed in this report is implemented and fully utilized by the municipalities, with leadership and encouragement from the Waste Management Branch. Such systems of cost measurement and control are needed given environmental concerns which are placing upward pressure on waste management costs during a time of constraint in public expenditures. Furthermore, an intimate understanding of the cost components is required in order to properly assess new techniques for waste management and develop appropriate policies within Ontario.

The report which follows describes the work carried out in this assignment and concludes with our recommendations for the scheduled implementation of the system on a full scale basis with larger municipalities (over 10,000 population) throughout Ontario during 1980. We also suggest that the Ministry consider the introduction of a shorter version of the municipal data form for smaller municipalities (under 10,000 population) in 1982 if experience confirms that further benefits will accrue from the analysis of data for the entire province. Since this would require the inclusion of an additional 688 municipalities in the annual report, a careful review is warranted.

II. ASSESSMENT OF SYSTEM PRACTICALITY, BENEFIT AND COST WERE KEY OBJECTIVES

The key objective of the pilot implementation project was to determine whether the introduction of the costing system on a province-wide or selective basis would be beneficial to municipalities, and to provincial policy-making bodies. By its very nature, a major aspect of such a pilot implementation assignment involves an assessment of the benefits of the system and the practicality of wider scale implementation. Key questions reviewed and assessments made during the project included the following:

- Can and will the sample municipalities provide the financial and operating data required to produce the comparative provincial reports?

- By reviewing the participation level of these sample municipalities, what is a realistic estimate of future participation by an expanded number of municipalities?

- Does the provincial report provide comparative data that will be of use to municipalities to help them improve operating efficiency; will this comparative data also be of use to the provincial bodies in determining solid waste management policy?

- Can solid waste density factors be developed that can be used for predicting solid waste tonnage in non-weighing municipalities through the use of truck counts?

- Can such annual predictions be based on periodic truck count sample data, by taking into account variations in seasonal solid waste generation through the use of monthly and weekly factors?

These questions and other relevant issues were reviewed during this assignment. The report results which follow indicate that expanded implementation of the costing system is practical using refined data forms, if one person within the Ministry's Waste Management Branch is dedicated to co-ordinate this program. The following sections of this report outline the work steps that were undertaken during this assignment, our findings concerning the usefulness of the data generated, and our recommendations for a province wide implementation in 1980 for municipalities with populations in excess of 10,000 people.

III. PARTICIPATION WAS GOOD AND COMPREHENSIVE DATA WAS DERIVED FOR ASSESSMENT

The following subsections describe briefly the work undertaken, which was basically in keeping with the consulting program set out in Appendix I, and also describe the key results of the pilot implementation. Comments are included on areas where the prototype system has been enhanced, and conclusions are reached concerning the requirements for more extensive implementation of the costing system.

A. MUNICIPALITIES PARTICIPATED WILLINGLY WITH VARYING DEGREES OF COMPLETENESS OF DATA FORMS

In this subsection we examine the success in soliciting financial and operating data from the nine sample municipalities (3 upper tier and 6 local), review problem areas related to completing the data forms, and assess the timing over which wider scale implementation can be achieved.

1. The Majority of Municipalities Completed the Returns

Eight, of the nine municipalities responding, completed the data forms in a reasonable time frame (between one and three months). In the case of the major Metropolitan area the majority of the

data was prepared by the consultants using the basic information supplied by the municipality. A tenth, smaller municipality, was originally approached as part of this sample, but since it did not respond within the six month study period its figures were not included.

The nine municipalities that co-operated in the pilot implementation may be categorized as follows:

- a metropolitan municipality with over 1 million population,
- a metropolitan borough with a population of approximately 400,000 people,
- a southwestern city with 250,000 population,
- a northern city and the corresponding northern region with 100,000 population,
- a southeastern city with a population of approximately 125,000 people,
- a regional municipality of 400,000 population adjacent to the metropolitan area,
- a suburban city of approximately 275,000 population within the above mentioned region, and
- a small rural township with a permanent population under 10,000 people.

In terms of full-time effort involved to complete the input forms up to one man-week of effort is required in most municipalities depending on their size, and up to two weeks work will be required for the major Metropolitan area. The differences in time required depends on whether the data already available at municipalities relate well to the required cost-accounting form; that is, whether such data are normally accummulated or summarized adequately for internal management and cost-control

purposes. In general such data are available for municipal operations, whereas if contractors are used the data are often not readily available at the required level of detail.

From our review of the information and based on discussions with municipal staff it became evident that the layout of the original form could be restructured to facilitate completion. It was also evident that the inclusion of examples in the cost-accounting manual will help the many different municipalities' staffs when faced with the task of completing the forms. As a result of the above, the municipal data forms for collection costs were restructured and simplified. The refined collection forms are illustrated in Appendix III. The accent has been placed on gathering the key information first, and the secondary information is given less emphasis.

Ministry staff will be refining the disposal data input forms to reduce the number of pages, and will attach instructions for completion, including examples. The format for the refined disposal forms is expected to be similar to the refined collection forms, and should enable key data to be contained on two facing pages.

2. Quality of Municipal Data Input was Reasonable

Comments in this subsection relate only to those municipalities that completed the input forms themselves. The quality and completeness of municipal data varied based on the nature and complexity of operations. In overall terms, a review of the data indicated that a reasonable amount of effort was made by municipalities to provide accurate information. There were four specific areas, however, where extra attention was required to edit the data from certain municipalities.

a. Allocated Overheads were Adjusted to the Levels Suggested in the Cost Manual

There were major disparaties in the amounts of overhead cost allocated to both collection and disposal operations which are analyzed in detail in Appendix III. Allocations ranged from zero in three municipalities to a high of 76% of direct labour cost in one landfill operation. This type of disparity was recognized in the 1978 study and a "normalized" technique established to eliminate such misleading cost variations. To resolve the current disparities, which again appear to be due to anomalies in accounting treatment rather than operating performance, a "normalized" overhead computation was made as per the cost manual. This was compared with the actual municipal allocations reported to us. For the six municipalities that made allocations, the total municipally allocated overhead cost was within $20,000 or 1.6% of the computed allocation. Thus substitution of the computed allocation in the Provincial reports will not affect the total overhead dollars drastically but will ensure that per ton variances between municipalities relate principally to the more accurate direct costs rather than being unduly affected by arbitrary overhead cost allocations.

b. Capital Costs for Collection Fleets were Reasonable

In the case of the capital cost element there were several distinct areas requiring a thorough review to ensure reasonableness of the figures. For collection equipment, depreciation and interest cost allowances were made by all three municipalities that operate collection fleets. The calculations were reviewed based on the size, type and age of fleet; the capital cost allowances were consistent given the variations in fleet age and initial purchase cost differences. The usual depreciation period of seven years was considered reasonable.

c. Capital Costs for Some Landfill Sites had to be Estimated

When reviewing the capital costs allocated to landfill operations less complete information was available. Of the five municipalities having landfill operations, (excluding the Metropolitan area) two were able to calculate landfill capital cost estimates. The other three municipalities had no capital cost estimates due to landfill sites being taken over at no cost or at a non-identifiable cost during "regionalization".

To overcome the lack of landfill site capital cost data estimates were made based on the projected cost in 1978 dollars of a new landfill site in a major suburban region near Toronto. The capital cost per unit of capacity in this "benchmark" landfill site was estimated at $3.16 per ton or $1.51 per cubic yard of capacity. These costs were then used in setting capital cost values based on capacity in the three municipalities lacking such asset records. The capital cost per ton for the "benchmark" site compared reasonably well with that of a major South Eastern City ($3.60) where a new site was also purchased and developed in 1978. Further details of these calculations are included in Appendix III to support any additional estimates required in future years.

d. Municipalities Should Require Additional Operating Data from Contractors

Incomplete data were available for municipalities that contract-out their collection operations. In these cases there were very limited data available for routes, route and haul miles, and number of pick-up points. Municipalities should request these kind of data in their contract terms.

Only by reviewing these statistics and comparing them with those of other municipalities, using the proposed provincial reporting system, can these municipalities have confidence that their contract costs are reasonable.

3. The Major Metropolitan Area Will be in a Position to Complete the Data Forms in Future Years

The municipal staff in the major Metropolitan area were unable to complete the input forms in a reasonable time due to staffing changes and other work priorities. Since the inclusion of this municipality's figures in the provincial report was considered important, the consultants gathered basic information from the municipality and prepared the data forms. The two areas requiring extra attention were the segregation of haul costs from station costs (transfer stations and incinerators), and the estimation of capital costs for vehicles and several disposal facilities. Examples of the consultants worksheets are included in Appendix III. Now that the basic calculations and estimates have been made, the completion of future years returns will be much easier, and can be carried out by municipal staff.

Municipal co-operation in completing the data forms met our expectations and was in keeping with the requirements of the system. We anticipate that, if say 100 additional larger municipalities were asked to participate in 1980, 60% should respond with reasonably accurate information. This assumes of course that the staff of the Waste Management Branch carry out the necessary presentations of the system to the municipalities. As knowledge of the benefits of the system becomes more wide spread, most larger municipalities with populations in excess of 10,000 should eventually participate.

When all of the larger municipalities are using the system, 93% of total provincial solid waste costs will be covered by the provincial reports. In the case of the 690 smaller municipalities in Ontario with populations of less than 10,000, a shorter form of annual input is available for any wider-scale system implemention that may evolve after 1981. This further implementation is suggested only if Waste Management Branch staff require more complete provincial data than is presently available within the Department of Treasury and Economics Municipal Financial Reporting System. Examples of the "short form" of annual input are included in Appendix III.

B. A BRIEF ANALYSIS OF THE PROVINCIAL "PILOT" REPORT INDICATES THE EFFECTIVENESS OF COMPARATIVE MANAGEMENT COST INFORMATION

The following comparative review using the "pilot" provincial report suffers from the small sample size but is, nevertheless, useful. It should be recognized that the nine municipalities were selected to test the ease with which the data forms could be completed by a wide range of respondants. Following the results of the pilot system test summarized in this report, the objective is to request provincial data forms from an additional 102 "collecting" municipalities and an additional 69 "disposing" municipalities. With a large proportion of these additional municipalities participating in the proposed reporting system more meaningful cost and performance comparisons can be made and this should lead to cost reduction activity taking place on an ongoing basis.

From our analysis below it is evident that even with data from a limited number of municipalities certain cost and performance anomalies are evident. This analysis was carried out in a similar manner to our initial report in 1978; that is, by reviewing major cost anomalies and then examining those operating and performance characteristics which seemed to explain the cost differentials.

A summary comparison of the 1976 and 1978 prototype provincial report data was made and there was reasonable correlation of the statistics in many areas, after allowing for inflation. However, detailed comparisons were made difficult because computed overhead allocations and revised capital cost calculations were used in the 1978 return pursuant to our recommended reporting policies. The figures in the 1978 provincial report reflect more realistic cost levels for these items. Details of the comparative analysis of the 1978 provincial reports is shown below.

1. Costs of Municipal Collection Operations Were Compared

   Of the nine sample municipalities, three were operating municipal collection services. One was a city in South-Western Ontario (population in excess of 200,000). Another was a Northern Ontario City of 100,000 population, and the third was a metropolitan suburb of 400,000 population. Key observations from our comparisons were as follows:

   - All three municipalities were weighing the waste, therefore the tonnage figures are reasonably accurate.

   - Total municipal collection costs for the Northern Municipality ($37.78) and the large metropolitan suburb ($36.78) were 17% to 20% higher than for the large South-Western City ($31.54).

   - The major reason for the higher costs was in both cases higher labour cost (+ 35% to 45%).

   - Collection route productivity in the Northern city was correspondingly 24% lower than in the South-Western city. This data was not available for the metropolitan suburb.

- The reason for higher labour costs was probably due to two collections being performed weekly in the two higher cost municipalities rather than the one weekly collection in the other municipality.

- It could not be proved that the differences in municipal crew size caused the cost difference, since the large metropolitan suburb averaged a lower crew size than the South-Western City, but had a higher cost per ton.

Based on the above summary analysis of municipal collection costs, the following actions may be appropriate:

- The large Northern city and the metropolitan municipality should re-evaluate the current twice-weekly collection service levels in relation to citizen's priorities and fiscal requirements. The Northern city is already contemplating a service level change to once-per-week collection.

- Although higher crew sizes were not proved to be more costly the Northern city and South-Western city should consider reducing crew sizes based on individual feasibility studies at each municipality.

When a larger stratified sample of municipal data is available where there are less differences in operation between specific municipalities, it should be easier to draw firm conclusions on the performance improvements and cost reductions required. In other words, if all but one key operating characteristic are similar, the reader may be able to relate a cost differential to one specific operating variation. Action can then be taken to improve operating performance and subsequently reduce costs.

If the two higher cost municipalities mentioned above were able to achieve the same efficiency and cost level as the other municipality and this level of savings was extrapolated over all municipalities with populations over 10,000, this would equate to a $3.6 million annual cost reduction on a Province wide basis.

2. Haul Costs Require Segregating to Improve Analysis

Although the municipal input from required segregation of the haul element of collection labour hours, several of the sample municipalities were unable to complete this data. As an interim measure, an assessment of the percentage of haul cost of total collection cost, related to haul distance was made, as shown in Appendix III. This analysis resulted in a haul cost percentage factor being estimated which can be applied to cost data from any collecting municipality. Elimination of the variable haul cost element then permits the more appropriate comparison of the route collection cost per ton. We recommend that the haul cost percentage factor be used by the Waste Management branch staff to help their analysis, until more accurate data is available from municipalities. It will probably be necessary for branch staff to highlight the need for haul cost data on the municipal input forms and instructions, to help ensure municipalities comply with the request. Subsequently, more meaningful comparisons of collection route costs per ton, excluding the haul element, can be made to help municipalities highlight collection methods and costs which are excessive.

3. Contract Collection Comparison is More Difficult Due to Less Data Being Available

Five municipalities were operating contract collection operations as follows:

- A portion of the large Metropolitan suburb and the Northern city mentioned in the subsection above,
- A South-Eastern city in excess of 100,000 population,
- A large suburb of 250,000 population, and
- A small rural township of less than 10,000 population.

The first two municipalities mentioned, contracted out approximately 10% of their total collection, while the other three municipalities contracted out pick-ups for all households requiring collection. In the small rural township not all households were given collection services.

Key observations from our analysis were as follows:

- Only the large suburban city weighs the waste.
- Reported contract cost per ton collected seemed inaccurate and ranged from a low of $11.64 per ton in the large metropolitan suburb to $53.66 per ton in the Northern Ontario city.
- The reported estimate of pounds collected per household by contractors varied excessively (3,889 pounds in the large metropolitan suburb down to 1,586 pounds in the Northern city).
- The differences in estimated waste generation for contractors pick-up was considered abnormal compared with the pounds collected municipally. Thus, the tonnage

estimates for contract collection were "normalized" based on the weighed pounds per household recorded for the municipal collections in each location (1997 pounds and 1961 pounds per household respectively).

- After normalizing the weights, the cost per ton in the large metropolitan suburb is estimated at $21.59, which appears more reasonable. The cost per ton in the Northern municipality at $41.34 still appears high.

- The collection frequency, point of pick-up and crew size for the above municipalities were similar.

- The haul distance to the disposal site, however, was more than twice as far for the Northern city (7 miles) than for the metropolitan suburb (3 miles to the transfer station)

- The cost of transferring the large metropolitan suburb's waste to landfill adds another $9.59 per ton to the disposal cost making the total approximately $31.18 per ton.

We concluded that the estimated contractor tonnages were probably highly inaccurate in certain municipalities, and that the cost in the Northern city was being affected by the longer haul distance to landfill. Action that is warranted based on our review is as follows:

- weight estimation for contractors should be improved to permit better performance measurement and comparison, and

- the northern municipality should specifically review its contractor's performance and terms, to determine whether these are reasonable in the light of the high unit cost.

Another comparison made between contract collection operations was for the South-Eastern city with 125,000 population and the suburban city with 275,000 population indicated the following:

- The South-Eastern city contract collection cost was $29.70 per ton, while the other municipality had a collection cost of $22.94 per ton.

- The collection frequency was slightly higher in the suburban city however, (1.5 times per week). Crew size was similar.

- The South-Eastern city pays a premium for optional rear yard pickup as opposed to curbside pick-up in the suburb.

Thus, the South-Eastern city is paying a premium for the optional rear yard collection that appears to be more than offsetting the lesser frequency of collection. Accordingly, in assessing its costs, service levels and citizen's priorities:

- the South-Eastern city could consider eliminating the rear-yard collection option except in special circumstances (e.g., for pensioners), and

- the suburb may wish to consider reducing collection frequency to once per week.

The contract collection cost in the small rural municipality was, after review, the lowest in the sample ($15.66 per ton), and without the benefit of other comparisons, considered reasonable.

Since collection costs represent in excess of 60% of the Solid Waste costs within the province it is very important that this

section of the provincial monitoring report receive a high proportion of the analysis time and effort spent by the Branch staff once the system is implemented on a wider scale.

During our review of the capital costs of collection fleets the adequacy of the municipal charges was verified. If rapid and continual inflation occurs in the cost of replacing vehicles however, these capital charges should be increased on an annual basis to ensure that the total collection costs reflect realistic capital replacement costs.

4. Landfill Costs Vary and Will be Better Evaluated With a Larger Sample

There were four sample municipalities operating landfill sites. Once landfill site capital costs were estimated and included, several comparisons were made, as follows:

- Total cost per ton landfilled ranged from $2.91 in the metropolitan Toronto area to $8.51 per ton in the large South-Western city. It should be noted that the metropolitan cost was only for landfill operations and excluded transfer station and incineration costs.

- Of the $8.51 landfill cost of the South-Western city $2.24 was the estimated capital cost of a new site opened in 1975.

In the sections below, some of the reasons for cost variations for landfill operations are examined.

a. Capital Costs Ranged From $0.38 to $3.60 Per Ton Of Capacity

Capital costs of landfill were $0.38 in a small rural municipality and ranged up to $3.60 per ton in a South-Eastern City that had developed a new landfill site in

1978. In the three sites where estimated landfill site costs were used (based on the 'benchmark' landfill cost per ton developed using a new regional site), the unit costs were between $2.02 and $2.24. The cost per ton in the Metropolitan area was $0.99 based on the consultants' specific estimate of this capital cost.

Capital costs per ton will continue to vary between municipalities depending on location and size of site. Thus capital costs will need to be extracted from total landfill costs to make more meaningful comparisons of other landfill costs. As landfill site acquisition and development costs escalate due to shortages of suitable sites and increasingly stringent environmental requirements, this cost element will become more significant and will require continued monitoring by Waste Management Branch staff.

b. Operating Costs Also Vary Between Sites

If we exclude capital cost and examine operating costs for municipally operated sites we find the following variations in cost per ton:

	$ per ton
Large South-Western City	6.27
Small Rural Township	6.88
Metropolitan Area	1.92
Large Regional Municipality	3.68

The apparent reasons for these operating cost variances are discussed below.

i. Labour Costs Varied Widely

Labour costs in the above showed wide differences as follows:

- The small rural townships' labour cost per ton was $4.39 due to there being a "one-man fixed cost" operation and low tonnage.

- Labour costs in the South-Western City ($2.53) were affected by further development of a new landfill site with municipal employees' participation. Litter patrol activity was also regarded as being heavy at the city's new site compared with the city's old site, since the new site was located in an adjoining township.

- Labour costs in the other two municipalties were similar at approximately $1.00 per ton landfilled.

ii. Equipment Costs Also Varied Significantly

Equipment costs were also higher at the same two sites mentioned above.

- The similar "fixed cost/small tonnage" appears to be a reason at the small rural township ($1.55 per ton).

- Additional equipment rentals for the capital work being done at the South-Western city's new site is one reason for higher cost (not quantified).

- Equipment costs at the other two municipalities were similar. ($0.48 and $0.59 per ton).

iii. Direct Overhead Costs Varied Extensively

Although overhead allocations for general management and administration were included in the provincial report using the policies laid out in the cost manual manual, wide variations in cost per ton for total overhead were still evident. If we exclude the administrative overhead allocation portion, the remaining direct overhead costs per ton for training, supplies, etc., ranged from $1.98 per ton landfilled in the Region with 400,000 population, to $0.17 per ton landfilled in the metropolitan area.

After a detailed review with the Regional Municipality it was found that $0.65 of the $1.98 direct overhead related to the purchase and haul of cover materials for the completion of one landfill site. Cover materials were not purchased at the Metropolitan sites since private disposers were bringing in an adequate supply of fill to complement cover materials available on the landfill sites. The remaining variance between costs at the two sites ($0.17 to $1.33) was due mainly to the differing scale of operations (5:1 ratio) between the two sites. After this adjustment of cover materials, the direct overhead cost for the region ($1.33) was also much more comparable with the South-Western municipality ($1.47 per ton) where cover material costs were very minor.

In future, the Branch should request that cover materials be identified separately by municipalities in the cost data reported. This refinement of data requirements can be added by Branch staff when the disposal data input forms are restructured to limit the number of pages.

iv. Revenues From Private Users Ranged from Nothing to $8.32 Per Ton

There were no revenues collected from private users in two municipalities and revenues then ranged up to $8.32 in the metropolitan Toronto area. Municipal staffs are concerned with the following points:

- A perception that charge rates need to be related to competitive private landfill site rates (e.g, South-Eastern Municipality), or that there is a possibility of individuals dumping waste in the countryside if high rates are charged. (Northern city and the rural township).

- In the metropolitan area pricing arrangements are made more complicated by the alternatives available to users (e.g., transfer stations, incinerators and landfill sites).

These are reasonable concerns, however, suitable charge rates should be initiated where practical.

v. Appropriate User-Charges Should Be instituted

If the charge rates at all landfill sites operated by municipalities of more than 10,000 population (but excluding the metropolitan area), were increased to cover the actual cost per ton landfilled it is estimated that an additional $3.2 million in revenue could be generated. All municipalities should review their landfill charge rates for private users to ensure that the rates equal the landfill cost per ton

including an estimate for landfill site capital costs. In this way heavier private users will not be placing a burden on tax-payers in general.

Increases in rates to realistic levels may need to be scheduled over several years so that the impact on industrial users is not dramatic. Sudden large disposal rate increases could discourage development for certain types of industry and upset the existing balance of growth between communities. These rate increases should also consider replacement costs due to escalating landfill site acquisition and development costs. To ensure equity in the charge rates to industrial disposers, municipalities should also install weigh scales.

Landfill site costs presently represent approximately 30% of the solid waste costs in the province. As landfill site development costs increase due to the escalation of land costs and more stringent environmental regulations, the proportion of landfill to total solid waste costs will probably increase. Thus this cost element, as well as collection costs, will require a continuing high degree of analysis and review effort by Waste Management Branch staff. One outcome of these analyses should be the development of data to help improve compaction at landfill sites to extend their useful life.

5. Reporting of Costs Within a Municipality Between Sites/Facilities Will be a Useful Computer System Modification

Although the current computerized reporting system will not allow multiple lines of data for one municipality, this feature should be added by the Waste Management Branch at a later date. To

review the usefulness of this addition to the provincial reporting structure a brief review of transfer station, incineration, and landfill costs in the Metropolitan Toronto is area discussed below. Comments are also made on Resource Recovery operations.

a. Transfer Station Costs Within the Metropolitan Area Averaged $5.47 per Ton But Varied Widely Between Stations

A brief analysis of comparative transfer "station" costs indicated wide ranges of costs per ton from $11.40 down to $2.80 per ton. Even after excluding capital cost estimates which were calculated based on the age of the facility, the range of cost per ton was from $8.49 to $2.31; still a major spread. As well as cost per ton variations occurring through differing capital costs, we concluded that another main reason for variances was due to volume, since most costs appear to be relatively fixed. An in-depth study by the municipality concerned is warranted to explain the cost and volume differences between stations.

b. Incineration Costs Per Ton at $17.55 were 40% Higher Than Transfer Station plus Landfill Costs

A brief review of the comparative costs of incineration in the metropolitan area showed that costs ranged between $14.72 to $15.44 per ton, and averaged $15.03 per ton. Once the ash haul and disposal cost was added the incineration cost per ton was $17.55. Assuming that transfer station, haul, and landfill is the alternate disposal method, the average cost under this option would be $12.49 per ton. The 40% disparity in total disposal cost warrants continued

consideration of alternatives. If any of the transfer stations are operating below capacity they may represent a useful alternate disposal method at this time until the rising fuel costs of the haul and increases in landfill site capital costs drive this alternative to a higher cost level. This of course, assumes that sufficient landfill sites can continue to be developed.

c. Landfill Costs Per Ton Varied Widely in the Metropolitan Sites Depending on Volume

Landfill costs for the two major metropolitan landfill sites were $2.17 and $2.93 per ton landfilled. The cost for a smaller site (less than 10% of the tonnage of the other sites) was $8.36, indicating the incidence of certain semi-fixed costs on the smaller landfill sites (e.g., foreman and scale house labour costs). The smaller site has now been closed for an undefined period, and we understand that measurement of labour performance at the other sites is continuing using a man-hours per ton landfilled ratio. Even though landfill costs are influenced by "fixed" cost elements, the municipality should continue its cost monitoring activity and attempt to bring its higher cost site ($2.93 per ton) down to the more economic cost level displayed at the other site ($2.17).

d. Resource Recovery Feasibility Must Continue to be Monitored

In our previous report we noted that economically feasible resource recovery is still in the development stages. It is evident that product-market considerations as well as escalating landfill site acquisition costs will continue to be major factors in determining feasible recovery methods.

Due to the current and future upward price pressure on oil and other energy sources the Waste Management Branch and the Advisory Board will continue to monitor the development of successful recovery and related energy-from-waste applications both in Canada and internationally. At this point the recommended provincial monitoring report contains data on one municpality concerned with ferrous metal recovery. As further recovery techniques are tested and adopted, the data base contained in the monitoring report will expand accordingly and become more useful for comparative purposes.

Although the foregoing site-by-site comparisons of cost and performance within the sample municipalities were limited, individual municipalities will be very interested in seeing this data on a larger scale in future monitoring reports. Once the reporting system has "settled" into a standard format, the Waste Management Branch should carry out the custom programming required to give multi-line municipal detail.

Our previous report described many issues that the proposed provincial report may help to quantify so that they may be resolved. These issues include the following:

- The adequacy of industrial dumping fees,
- The costs and benefits of recycling,
- When incinerators and transfer stations should be used,
- The cost impact of a once versus twice per week collection service, and

- Which types and sizes of collection vehicles are most cost-effective.

Based on the work carried out in the pilot implementation project it is evident that the data provided in the provincial monitoring reports will help policy-makers develop recommendations concerning the foregoing and other contentious solid waste issues. Further details of the anticipated benefits of wider-scale implementation are described in Section IV of this report.

C. SOLID WASTE DENSITY FACTORS ARE NOW AVAILABLE FOR INTERIM USE

One of the major activities undertaken during the assignment was the development of solid waste density factors for selected categories of vehicle. These province-wide density factors were developed following a sample weighing program that was carried out during one-week periods at six landfill sites equipped with scales. In addition, seasonal tests were made at two landfill sites and adjustment percentages derived for seasonal density changes. Methods for annualizing the weekly weight totals were also developed based on monthly weight proportions from several metropolitan landfill sites.

The objectives for developing the factors and seasonal adjustments were twofold. First, they can be used by non-weighing municipalities to estimate total annual solid waste tonnage based only on a few sample truck counts of one week's duration. Second, the density factors can be used by weighing municipalities to check their own vehicle and crew performances against these standard density factors. The key steps in this part of the assignment, plus the results, and examples of the use of the density factors in computing annual weights are included in the following subsections and in Section D following.

1. Truck Weights Sampled at Six Scale Locations Varied Considerably

The basic truck weight data used to derive the province-wide density factors was collected from six scale locations; four were in Metropolitan Toronto, one was in the Region of Peel, and one was in the City of London. Six locations were chosen rather than the one originally planned, so that a larger range of sizes and types of vehicles could be observed. The first sample taken was for a one week period in February 1979. Subsequently, a one week sample for two of the same sites (Beare Road and Brock West) were taken in May 1979, to aid with the verification of seasonal waste generation fluctuations. A further sample is to be taken in London and can be used by Waste Management Branch staff to further refine the density factors.

To collect the sample truck weight data, forms and procedures were developed (see Appendix II). The use of the forms was explained to the scalemen at each site, and they then collected the sample data for each incoming vehicle. Separate classifications were identified for type of vehicle operator, type of vehicle, size of vehicle, and type of handling (loose or compacted). Data was also gathered related to the time of the load, and the origin of the waste (e.g., residential versus non-residential).

Once the sample data was summarized, a limited amount of statistical analysis was undertaken to determine the confidence level with which the standards could be used to predict annual tonnages in non-weighing municipalities. Those tests, as described later in this report, indicate a wide range of densities depending on the operating practices of site-users. Thus, these sampled densities should be used only on an interim basis until "custom sample weighing programs" can be carried out in each non-weighing municipality.

Further details of the density analysis and summary results are included below.

2. Average Density Factors Were Developed For Interim Use

The key results of the truck weighing program are displayed on tables 1 and 2 following. These charts represent the summarized findings of the program, of which greater detail is shown in Appendix II. The results are structured to show the basic differences in density due to either compaction, operator category, vehicle type and vehicle size.

a. Compacted Waste Tends on Average to be Twice as Dense as Loose Waste

On table 1 following the basic density difference between compacted and loose waste is shown. The key results of interest are as follows:

- Compacted waste density averaged 183 kilograms per cubic yard which is twice as dense as loose waste (95 KG/cubic yard),

- The weight of contracted loose waste from municipalities and private loose waste is similar (90 KG vs. 96 KG),

- In the private sector Lugger Box waste is twice as dense (162 KG) as Roll-Off Box waste (87 KG), and

- The highest densities in loose waste are in the smaller lugger boxes which are normally designed for heavier materials such as demolition waste and heavy industrial waste.

Currie, Coopers & Lybrand Ltd.

RESULTS OF SOLID WASTE DENSITY SAMPLING OF COLLECTION VEHICLES: DENSITIES STATED IN KILOGRAMS PER CUBIC YARD

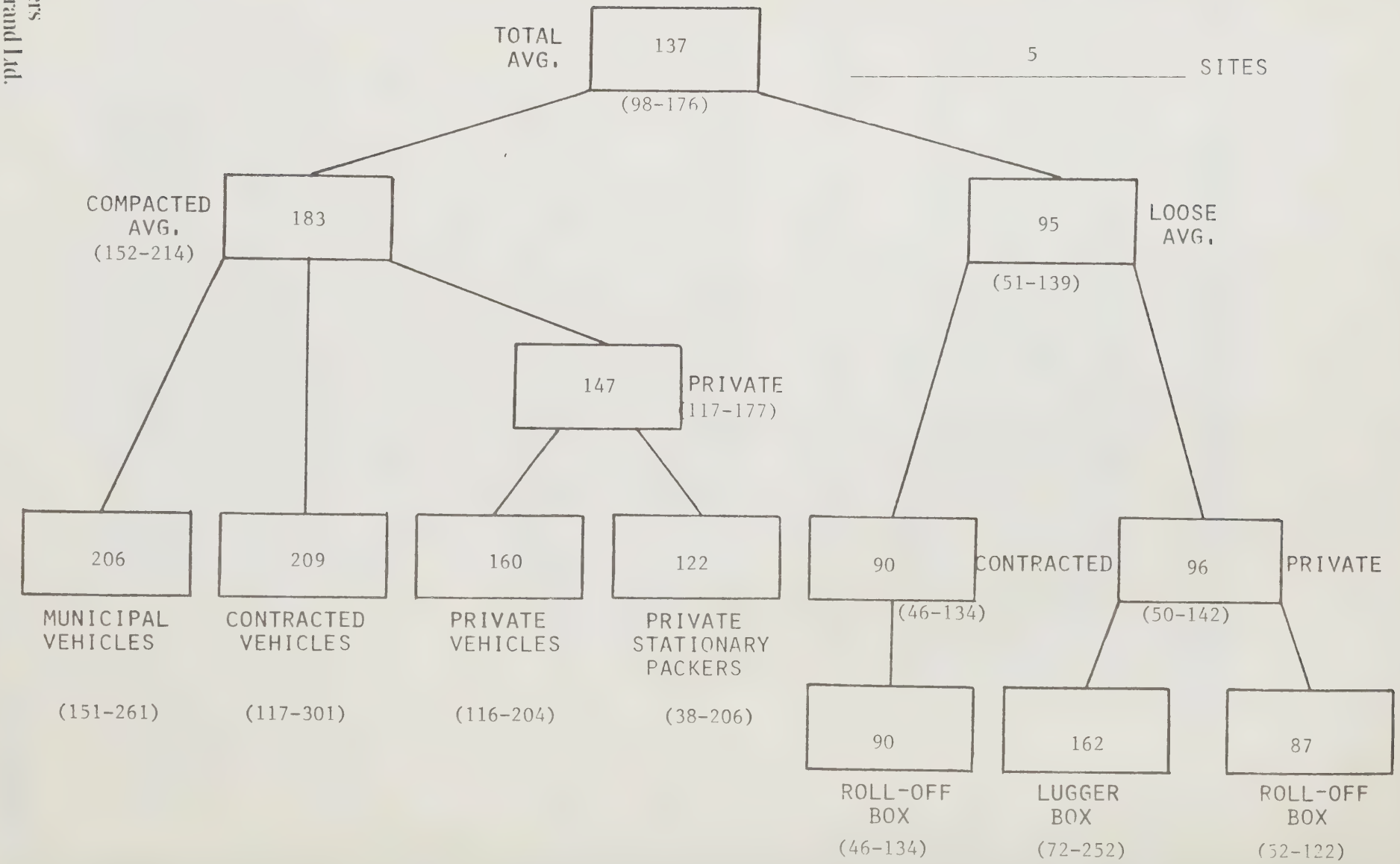


TABLE 1

Apart from minor anomalies in the density of the 14 cubic yard and 20 cubic yard Lugger Boxes, the density trends appear reasonable - i.e., in loose vehicles the larger boxes tend to have lower density loads per cubic yard than in the smaller boxes.

b. Contractors Compacted Densities are Generally Higher than Municipal or Private Densities

In table 2 following the compacted waste is displayed showing the density differences by operator, vehicle type and vehicle size. The highlights of this analysis are summarized below:

- The contractors (working for municipalities) average compacted density (209 KG) is slightly higher than municipal operators (206 KG) and 30% higher than private operators (147 KG),

- The highest densities achieved were as follows:

Operator	Vehicle Type	Cubic Yards	Density KG/cu. yd.
Contractor	Rear-Loading	25	291
Municipal	Rear-Loading	25	275
Municipal	Side-Loading	20	274
Contractor	Rear-Loading	20	263
Private	Front-Loading	25	246
Municipal	Front-Loading	35/36	243

- Although Municipal Front Loading packers (see Appendix II for details) achieved a higher density than contractors, municipal vehicles normally only take two loads per day versus the three or four loads per day

Currie, Coopers & Lybrand Ltd.

RESULTS OF SOLID WASTE DENSITY SAMPLING OF COLLECTION VEHICLES: DENSITIES STATED IN KILOGRAMS PER CUBIC YARD

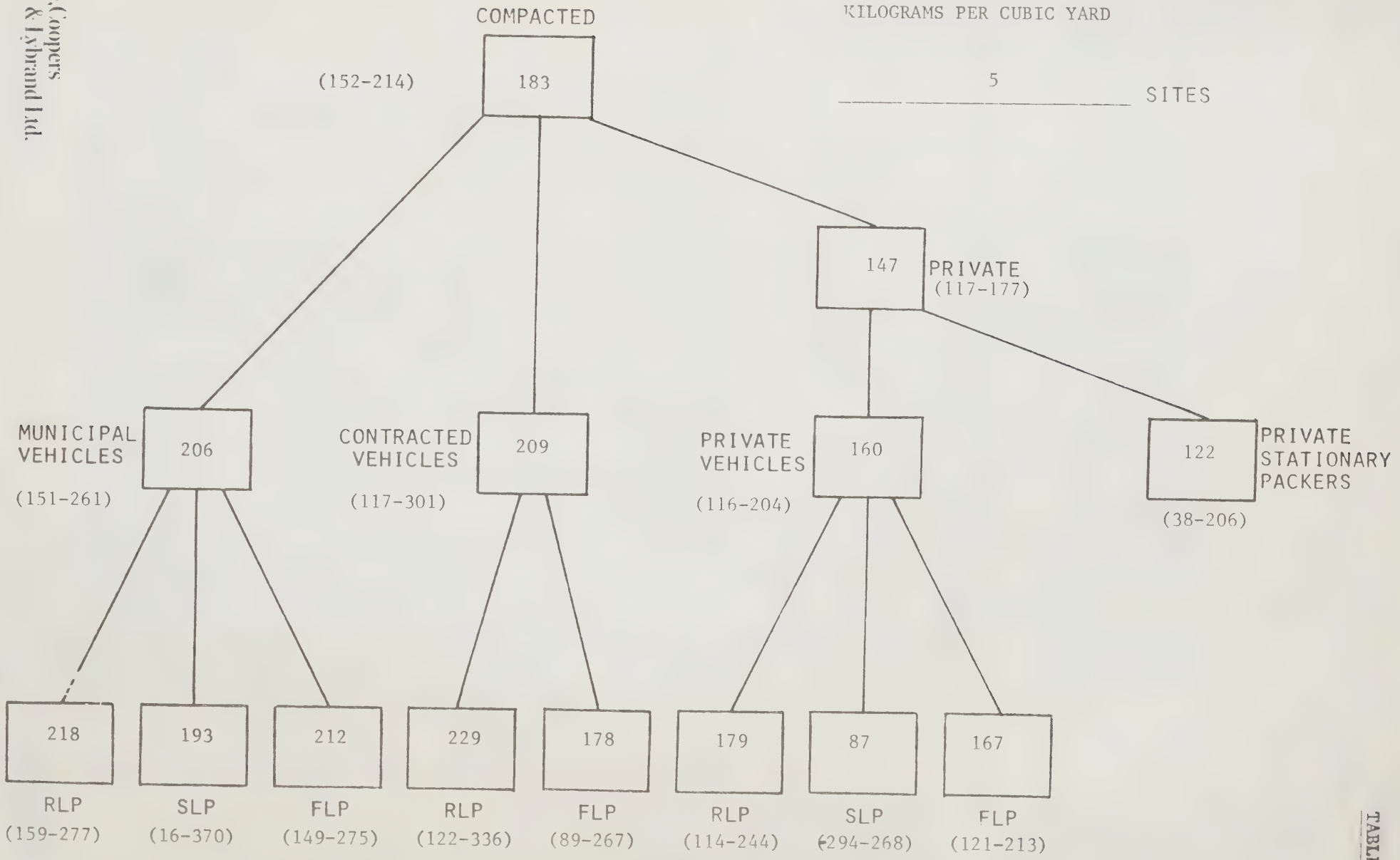


TABLE 2

for contractors vehicles. Thus total weight collected would tend to be considerably higher for contractors than for municipal crews.

- Private operators may have lower average densities than contractors collecting for municipalities since there are probably no vehicle age restrictions for private operators. Thus, older vehicles may tend to be used for private customers where daily reliability may be less important than competitive cost considerations.

The results of the above findings appeared reasonable for compacted waste, with minor discrepancies in results probably being due to smaller sample sizes.

The data collected on the relative performance of individual vehicle types and sizes should become very useful as these are updated and reported by Waste Management Branch Staff on an ongoing basis. Reports of comparative vehicle performances can be used locally by municipalities preparing capital investment proposals for new collection vehicles. Similarly, over a period of years, data on landfill site compaction vehicle performance can be tabulated and relayed to interested municipalities. This will enable them to review performance of their existing compaction equipment and may justify the purchase of more efficient equipment.

c. Lower Densities in Municipal Afternoon Loads Should be Reviewed

During the calculation of province-wide density factors, we reviewed differences between "a.m." and "p.m." densities for

municipal collection vehicles. Truck weight data for eight municipalities was gathered during the truck weight program carried out in February, and the "p.m." densities were lower in seven of the eight municipalities. On average, "p.m." densities were 20% less than those achieved in the "a.m. loads.

Although collection route planning may specifically allow for a lower number of pick-ups in the afternoon, to give a contingency allowance if morning routes are delayed, the range of densities (p.m. was from 59% to 108% of the a.m. density) warrants investigation by the municipalities concerned. Further details of the analysis are included in Appendix II for reference.

In summary, if a municipality lacks weigh-scales, truck counts may be used together with the province-wide density factors developed in this study and displayed on Table 3 on the page following. However, care must be used in applying these factors since they must be adjusted for changes in seasonal density which depends on the timing of the truck count sample as discussed in Section 4 below. Furthermore, individual "custom" density factors (also discussed below) are preferable because of the wide variations in densities between different sites and the attendent inaccuracies arising from the use of one province-wide set of factors developed in this study. The province-wide factors should be viewed as useful on a interim basis only.

3. Individual Municipal Density Factors Are Preferred and Should be Developed Through "Custom" Sampling

Basic statistical standard deviation calculations were used to determine the reliability of the province-wide density factors for predicting tonnages in non-weighing municipalities. Table 3

PROVINCE WIDE, INTERIM DENSITY FACTORS

DENSITY PROGRAM - INDIVIDUAL VEHICLE DENSITIES

(95% Confidence Level for Prediction Within the Upper and Lower Limits)

	% Spread from the Mean	Total Vehicle Load			KG Per Cubic Yard
		Upper Limit	Mean	Lower Limit	
RLP-M (20)	±16.9	5,074	4,339	3,605	217
RLP-M (25)		8,586	4,877	1,168	195
FLP-M (30)	± 2.0	6,088	5,966	5,844	199
FLP-M (36)		16,854	8,299	-396	231
RLP-C (20)		7,618	4,987	2,356	249
RLP-C (25)		16,567	7,422	-1,723	297
FLP-C (36)		14,211	6,144	-1,923	171
RO-C (30)		4,178	3,015	1,852	102
RO-C (40)		7,312	3,217	-874	80
RLP-P (20)		5,069	3,600	2,123	190
FLP-P (30)		6,825	5,355	3,885	179
FLP-P (34)		12,303	7,081	1,859	208
FLP-P (35/36)		10,321	6,364	2,403	179
FLP-P (40)	±14.4	6,763	5,908	5,053	148
SP-P (20)		7,368	3,894	420	195
SP-P (40)		8,245	4,855	1,465	121
LB-P (12)		3,927	2,771	1,615	231
LB-P (14)		3,419	1,680	-59	120
LB-P (20)		6,695	2,518	-1,659	126
RO-P (10)		3,062	1,823	584	182
RO-P (14)		4,336	2,312	288	165
RO-P (20)		5,099	2,789	479	139
RO-P (25)		4,116	2,356	596	94
RO-P (30)		3,920	2,527	1,134	84
RO-P (35)		10,505	2,291	-5,923	65
RO-P (40)		3,673	2,656	1,639	66

following lists all of the key vehicle sizes by operator and category and shows the range within which there is 95% confidence level for predictive purposes. Key results of the statistical analysis are as follows:

- Only three of the vehicle types have a reasonably small spread from the mean:

		%
-	Rear-Loading Packers, Municipal	± 16.9%
-	Front-Loading Packers, Municipal	± 2.0%
-	Front-Loading Packers, Private	± 14.4%

- The predictability of the other vehicle densities shows very wide ranges of weight.

As a result of this analysis it is evident that although the province-wide density factors can be used on an interim basis by non-weighing municipalities, "custom" weight verification is preferred. Accordingly, our recommendations for the non-weighing municipalities are as follows:

- A sample truck count should be made.

- After analyzing the predominant truck types entering the landfill sites, a sample of these predominant vehicles should be weighed to determine the density range that they fall in.

- These "custom" densities for the predominant vehicles should then be substituted in the list of province-wide density factors used to predict annual tonnages.

Although we recognize that the province-wide density factors derived in the consulting study show wide ranges for predictive purposes it is suggested that these factors be used in the initial province-wide implementation, until actual sample weight data is available on a "custom-basis" for each of the municipalities concerned. Tests carried out to validate the effectiveness of custom weighing programs for predominant vehicles showed that accuracy of tonnage estimates would be improved. Continuous weighing of all vehicles entering the landfill site is most desirable to ensure accurate tonnage data and, in the long-run, this is the recommended approach.

4. Seasonal Truck Density Adjustment Percentages are Suggested for Use With Monthly Truck Counts

The province-wide density factors described in Section 2 above were developed in February, 1979 and reflect average actual waste density in that month for each vehicle type in the sample. Thus, if a non-weighing municipality takes a one week truck count in February the province-wide density factors can be applied to arrive at a total estimated weight for that week. This one week sample weight can then be "annualized" using the weekly weight proportions of annual solid weight generated (see Section 5 following for detail). In many cases, however, municipalities will take weekly truck counts in other months (e.g., May, when the waste volumes are traditionally higher). When truck counts are taken in other months it is important to recognize that the different amount of waste is generated not only by different numbers of truck loads, but is also due to varying densities within the vehicles because of the season.

a. Seasonal Density Changes Account for More Than One-Third of the Seasonal Waste Variations

To define the two contributory factors (i.e., truck volume and density) that cause seasonal waste variations, additional weekly truck weight samples for May were taken from two of the six original landfill sites used to prepare the province-wide density factors. The resulting density factors obtained from the second sample were then compared with the February results. In summary, the differences obtained from the analysis were as follows:

Increase/Decrease May Data vs. February 1979

	Beare Road Landfill site Increase/Decrease in			Brock West Landfill site Increase/Decrease in		
Operator and Type of Waste Categories	Total Weight	# of loads	Density KG per cubic yd. or per load	Total Weight	# of loads	Density KG per cubic yd. or per load
Municipal Compacted		+36%	+35%		+72%	+33%
Municipal Misc. Loads		-43%	-53%		+340%	+730%
Contractors Compacted		+67%	+107%		-	-
Private Compacted		-33%	+21%		+19%	+7%
Private Loose		+50%	+42%		-9%	+32%
Private Misc. Loads		+103%	+30%		-	-
Total Increase	+66%	+40%	+26%	+78%	+48%	+30%

From the foregoing table it is evident that the total weight increases (66% and 78%) are comprised of both increases in number of truck loads and increases in the density per load. Since the sample from Beare Road was much larger in terms of total weight these percentage increases were used for further analysis to develop the density adjustment factors.

Before seeking to apply the density portion of the total weight increase in our sample (26%) it is necessary to correlate the total sample weight increase (66%) with the total weight increase for the metropolitan area (21.2%). The Metropolitan seasonal weight variations are shown on Table 4 following, and they are more reliable since they are based on four years of data.

b. The Seasonal Weight Samples Were Reduced Proportionately Based on the Metropolitan Average Weight Variations

The weight increase in May over February for the Metropolitan sample is as follows.

	February	May	Increase
One Week's Waste as a Percentage of Annual Total	1.70%	2.06%	+21.2%

The reader will note that the 21.2% seasonal total weight increase, compares with a 66% increase at Beare Road for the small sample we initially undertook to test density variations. We concluded that the higher weight increase in the Beare Road sample was due to a long weekend preceeding the sample, and therefore the density adjustment factors were proportionately reduced as follows:

SEASONAL SOLID WASTE DENSITY ADJUSTMENT PERCENTAGES

	FEBRUARY BASE	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY
A. Seasonal Weight Proportions												
1. Weekly weight proportions per Metropolitan Toronto	1.70%	1.81%	2.10%	2.06%	2.19%	1.92%	1.96%	2.05%	1.96%	1.98%	1.60%	1.58%
2. Increase/Decrease in Waste from February level.	0	+6.5%	+23.5%	+21.2%	+28.8%	+12.9%	+15.3%	+20.6%	+15.3%	+16.5%	-5.9%	-7.1%
B. Derived % Increase or Decrease in Density Factors:*												
3. Municipal Compacted Waste on Contractors Working for Municipalities	0	+3.5%	+12.4%	+11.2%	+15.2%	+ 6.8%	+ 8.1%	+10.9%	+ 8.1%	+ 8.7%	-3.0%	-3.7%
4. Municipal Loose Waste and Miscellaneous Loads	No adjustment, use weight per load											
5. Private Compacted Waste	0	+2.1%	+7.4%	+ 6.7%	+ 9.1%	+ 4.1%	+ 4.8%	+ 6.5%	+ 4.8%	+ 5.2%	-1.8%	-2.2%
6. Private Loose Waste	0	+4.2%	+15.0%	+13.5%	+18.4%	+ 8.2%	+ 9.7%	+13.1%	+ 9.7%	+10.5%	-3.6%	-4.5%

* Density accounts for a portion only, of total seasonal weight change, the balance being due to change in number of truck loads. The basic density % in B. above was derived for February and May by eliminating the effect of changes in number of truckloads. The density factors were then derived for the other ten months based on the monthly weight proportions shown in A. above.

TABLE 4

	Beare Road (1 week sample)	Adjustment of Weight & Density Based on Metropolitan Proportions (4 yrs. statistics)
• Total Weight Increase		
May over February base	+66%	+21.2%
• Density Change % Derived From Feb/May Sample of Loads and Total Weight		
Municipal Compacted	+35%	+11.2%
Private Compacted	+21%	+ 6.7%
Private Loose	+42%	+13.5%

For example, the Beare Road density adjustment increase for May of +35% is reduced to become a factor of 11.2% for province-wide use when a May truck count of municipal compacted waste is taken. This is accomplished by applying the weight ratio of the two samples (21.2/66) to the density variation derived in the Beare Road sample (35%).

Since there were no data available at Brock West to confirm the Contractor Compacted density increase at Beare Road it is suggested that the municipal compacted density adjustment factor be used until further sample data are collected.

Since the data showing density per miscellaneous load at the two sample sites varied (i.e., increased in two categories and decreased in another) and these loads represent less than 20% of total weight, these data should be disregarded at this time; thus the province-wide "per-load" weight estimates developed in February should be used until further weight samples are taken by Waste Management Branch staff.

The above description sets out the computation of density adjustment factors for broad vehicle/waste categories for a May sample. Similar density adjustment factors for the other months were also derived, and details of the calculations are described in the sub-section below and are shown on table 4.

c. Seasonal Density Adjustment Factors for Each Month were Calculated Based on the May Sample

Table 4 illustrates the use of the seasonal density adjustment factors for May (developed from Beare Road sample data), to calculate adjustment percentages for the remaining months in the year.

The first line of data shows the weekly weight proportions of annual waste for four years for Metropolitan Toronto and the second line of data represents the proportions of each weeks waste to the February base level.

The calculation of the May density adjustment factors (e.g., 11.2% for municipal compacted waste) was described previously in sub-section b. Using the monthly weight variations in line 2 of table 4 and the May density adjustment factors we calculated the other ten months of adjustment factors in the following fashion:

	February	May	June	% Increase June over May
Weekly Weight proportion	1.70%	2.06%	2.19%	
Weekly Weight increase over February	Ø	+21.2%	+28.8%	+35.8%
Calculated Density Adjustment Factors	Ø	+11.2%	+15.2%	+35.8%

The same process of using the May density adjustment factors as a base, was used to calculate the other months density adjustment factors which are shown on table 4.

A detailed example showing the application of seasonal density adjustment factors is shown in Appendix IV which describes annual weight estimation and truck counting procedures. The example shows province-wide density factors applied to one week's truck count data, and then revised using the seasonal density adjustment factors to reflect the month the sample was taken in. The resulting sample of one week's weight is annualized using the seasonal weekly weight proportions as set out in line 1 of table 4. The development and use of the annualization factors is described more fully in section 5 below.

5. Seasonal Solid Waste Proportions are Used to Estimate Annual Tonnage

In the preceeding sections we described the methods used to derive province-wide density factors and seasonal density adjustment factors. We also described the application of these factors to a weekly sample truck count to provide a total weight estimate for that week in that month. To derive an annual weight estimate the next step required is to extrapolate the weekly weight estimate into an annual tonnage using the weekly weight proportions developed for the Metropolitan area, as described briefly above.

The weekly weight proportions needed for annualizing one week weight samples to take account of variations in seasonal waste generation were developed by analyzing the Metropolitan area's seasonal waste variations for four years.

The seasonal statistics for the Metropolitan area for four years (1975 to 1978) were averaged. To test their general applicability, the monthly proportions were compared with 1978 statistics for a major suburban region and the waste generation trends were very similar.

Accordingly the monthly and weekly proportions developed using the Metropolitan area's data have been adopted on an interim basis for province-wide application. The weekly proportions of waste were simply calculated from the monthly proportions, (e.g., a week in February is 1.71% of the annual total waste, whereas February itself represents 6.8% of the annual total solid waste). Use of the weekly waste proportions to extrapolate from a weekly sample weight into an annual tonnage estimate is as follows:

$$\text{Weekly Weight } 1{,}000 \text{ KG} \times \frac{100\%}{1.7\%} =$$

58,823 KG Total Annual Weight Estimate.

As discussed earlier, a more detailed example of annualized weight estimation is included in Appendix IV.

In the preceeding sections the methods used to devise province-wide density factors, seasonal density adjustment factors, and weekly weight proportions were reviewed. The methods for applying these factors to derive annual total weight estimates were also reviewed. These methods and factors should be used by non-weighing municipalities to calculate annual solid waste tonnage. The information required to commence the weight computation are truck counts; the methodology for this is described in Section D below. The complete process for calculating annual tonnages is also summarized below. In addition, tests of the reasonableness of the results are illustrated.

D. A WEIGHT ESTIMATING PROCEDURE AND A TRUCK COUNTING PROGRAM WAS INITIATED

In this section of the report the following topics are summarized:

- The process used to estimate annual tonnages is summarized for the reader,
- The development and use of truck counting procedures are described,
- The results of tests carried out to assess the reasonableness of the various predictive factors, percentages, and proportions developed in this report are described, and
- The relative reliability of existing municipal tonnage estimates was compared with those which could be derived using the recommended weight estimating process to determine the acceptability of municipal estimates during the first year of implementation.

The pilot implementation showed that truck counting procedures can be used easily by non-weighing municipalities and that reasonably accurate projections of annual tonnage can be developed using the suggested estimating process. In addition, in the first year existing municipal tonnage estimates can be accepted. In the following section the process used to estimate annual tonnages is reviewed.

1. The Tonnage Estimating Process is Practical for Use by Municipalities

The process used to estimate annual waste tonnage from province-wide density factors and seasonal factors are described below. Basic steps of the process are as follows:

- Take sample truck counts, for four one-week periods during different seasons (e.g., February, May, August, and October).

- Carry out sample weighing of predominant vehicles, if weighing facilities are available. This will help determine custom density factors that can be substituted for the province-wide density factors.

- Apply the appropriate density factors per vehicle type, to the weekly sample counts and calculate total tonnage estimates for the four one-week sample periods.

- Summarize each of the weekly weight estimates into broad categories (e.g., Municipal Compacted, Private Compacted, Private Loose, etc.).

- Apply the seasonal density adjustment factors to each of the four weekly weight estimates for each broad vehicle category, e.g., February densities are not adjusted since this was the base period for calculating the province-wide density factors. May sample weights are adjusted based on table 4 (which follows page 36) to allow for higher densities in that month.

- When the weekly sample weights have been adjusted for seasonal density, each weekly weight is then extrapolated to give an annual tonnage, by using annualization factors, e.g., a weekly weight sample in May represents 2.06% of annual tonnage, whereas a weekly sample in February represents 1.70% of annual tonnage.

- The four estimated annual tonnages are then averaged to give one "best-estimate" of total tonnage for the municipality for the year.

A detailed example of the above estimating process is included in Appendix IV for use by municipalities. The starting point of the estimating process is the collection of basic truck count data. Section 2 below describes the truck counts that were initiated during the pilot implementation.

2. Truck Counting Procedures Are Easily Used in a Small Rural Municipality

Of the nine sample municipalities in this study, three were non-weighing and therefore required estimation of total weights for cost-reporting purposes. One of the three, a small rural township, did not estimate the landfill tonnage while the other two urban municipalities used truck counting procedures primarily for billing purposes, and then estimated the tonnage landfilled using their own rough density estimates.

To test the practicality of applying the proposed truck counting procedures, we carried out a truck counting program working with the small township. Details of the tests carried out using truck count data from the two other non-weighing municipalities is included later in Section 4.

Sample truck counts were taken in the small rural municipality for two one-week periods using the recommended sample form and recording procedure. The truck counts were taken in February and May 1979 to determine the ease with which such counts could be made. The process was instituted efficiently using the estimating process described above. The annual tonnage was

calculated for the municipality for use in their municipal input form. The method of calculation was explained to municipal staff and the process was readily understood (detailed calculations are shown in Appendix IV).

Based on the ease with which truck counting procedures were applied at the small rural municipality, it will be practical for larger municipalities to adopt the procedures for four one-week periods in the year. Having reviewed the applicability of truck counting procedures, tests were made to verify the suitability of the province-wide density factors, seasonal density adjustment percentages and annualization factors.

3. Density and Annualization Factors were Tested Successfully; Tests on Seasonal Density Adjustment Factors were Inconclusive

To verify the suitability of the density and seasonal factors derived in the study, tests were made as follows:

- Using truck count and actual weight data for February 1979, the province-wide density factors and annualization factors were tested with data from two landfill sites, and

- using two months's data from two other landfill sites, two annual tonnage projections were made for each site using the density adjustment percentages; the resulting total tonnages were then compared.

The province-wide density factors and annualization factors were tested successfully, but results of testing the seasonal density adjustment factors were mixed. The application of custom densities improved the accuracy of the estimates.

a. Density and Annualization Factors Were Tested Successfully

The data available to test density and seasonal weight proportions was for a sample week in February 1979 for a South-Western city and for a suburban region's landfill site. The weekly truck counts were extrapolated into annual tonnages, using the province-wide density factors and annualization factors. The resulting annual tonnage estimates for 1979 for each site compared very closely with the reported annual tonnages for each site for 1978. Although the tonnage comparison is for two succeeding years, the accuracy of the prediction appeared reasonable, and suggests that these factors can be used in non-weighing municipalities until weight scales are installed.

i. Density and Annualization Factors Were Applicable at a South-Western City's Landfill Site

Actual truck count data was used for a week in February 1979, and the province-wide density factors were applied to estimate a weekly weight total. This weekly weight was then extrapolated to an annual basis using the weekly annualization factors developed from four years of data from Metropolitan Toronto. The computed total annual weight was 10% lower than the actual weigh scale record for 1978. When "custom sample" density factors were substituted for predominant vehicles, the total annual weight estimate for 1979 was 7.6% higher than actual weight recorded in 1978. Thus the factors appeared to have a 10% range of accuracy at this site.

Assuming that there will be a 2% to 3% population increase in the city (1979 over 1978) the accuracy of the predictors would be even closer.

ii. Density and Annualization Factors Were Also Applicable at a Regional Landfill Site

The same process of applying province-wide density factors and annualization factors was carried out. The annual weight predictions for 1979 were 2.4% higher than actual weight reported for 1978 in the first test and 6.3% higher than actual 1978 weight reported when custom sample densities were substutited for predominant vehicles. Again population increases (1979 over 1978) may acccount for a large portion of the 6.3% variation.

From our tests, we concluded that density factors and annualization factors are readily applicable in non-weighing municipalities in the interim until weigh scales are installed to provide more accurate information. The next test carried out was of the seasonal density adjustment factors.

b. Testing of Seasonal Density Adjustment Percentages Was Inconclusive

To test the applicability of the seasonal density adjustment percentages, sample truck count data for two months in different seasons in each of two landfill sites was analyzed. Two annual tonnage estimates were then prepared for each municipality using province-wide density factors, seasonal density adjustment percentages, and annualization

factors. In one case, when February and May tonnages were extrapolated to annual figures, the results were within 3.4% of the "rough" municipal estimates, and at the other site the extrapolations were within 23% of each other. (see Appendix II for details). Since there were no actual weights available against which to check the extrapolations the results of this test were inconclusive. One possible reason for the apparent larger variance at one site (South-Eastern city) was that is was used principally by private users and an alternate less expensive landfill site was available. This factor may have caused fluctuations in site usage which would effect the applicability of seasonal density factors for predictive purposes.

It was concluded from this test that, where a landfill site is used consistantly by a standard mix of municipal and private operators, the seasonal density adjustment percentages are reasonable for prediction. In the case of sites with a varying mix of disposers, the use of weigh scales would be necessary to deterimine weight accurately. In the case in point, the South-Eastern city has installed scales to ensure that landfill tonnages are accurate and that disposal charges are equitable.

From the tests carried out, it was concluded that the province-wide density factors, and annualization factors could be used to estimate annual tonnage with reasonable accuracy. Extra care will be required, however, when applying the seasonal density adjustment percentages, since fluctuations in the mix and number of users of a landfill site will effect the average density in different seasons and subsequently the annual weight estimates.

4. Municipal Weight Estimates Can be Used in the First Year of Pilot Implementation

During the implementation project it was noted that of the three non-weighing municipalities involved, two already had truck counting procedures in place for billing purposes. Thus, rather than initiating the proposed truck counting procedures, a comparison of the rough municipal tonnage estimates was made to those derived using the density factors, seasonal density adjustment percentages, and annualization factors. Although the test results were mixed, it will be reasonable to use rough municipal estimates of tonnage in the first year of wide scale system implementation. To carry out the test, a sample of one month's truck count record was taken from two non-weighing municipalities. The province-wide interim density factors were then applied to the truck counts and the estimated tonnages were compared with those estimates previously prepared by the municipalities.

a. Use of Recommended Interim Density Factors in a Large Suburban Region Was Suitable

February and May 1978 truck counts were taken and interim density factors were applied for one site in a regional municipality. The forecast tonnages derived by density factors were compared with municipal tonnage estimates and initially were found to be 7.3% higher in February, and 23.3% higher in May. This analysis coincided with municipal analysis of landfill cubic capacity which also indicated that the tons being landfilled was previously being under-estimated by the municipality. Thus, the recommended interim density factors and seasonable adjustments have

proved to be useful in this case and are being used in 1979 by the municipality to adjust reported weights and increase charge rates to private users.

b. A Large South-Eastern City's Global Estimates Varied From the Recommended Totals

Density factors were applied to two landfill sites. At one landfill site used by contractors to the municipality, the density factor estimate for 1978 was 33,000 tons and the municipal estimate was 39,000 tons (+18%). For another site (mostly private users) the density factor estimate was 41,000 tons while the municipal estimate was 35,000 tons (-15%). Thus, although the total municipal weight estimate was the same as the density factor prediction (74,000 tons) there were large disparities between the two individual sites. It should be noted, however, that this municipality did not differentiate between loose and compacted waste in its tonnage estimates and thus their figures are probably less accurate.

From our analysis of truck counts and the application of the weight estimating process, we concluded the following:

- The appl·cation of density factors developed in this study to truck count data should be encouraged. This will provide more accurate tonnage estimates since the density factors that were developed are detailed by truck type and distinguish between loose and compacted waste.

- To further improve weight accuracy, municipalities should sample weigh the predominant vehicles at least once per annum to determine actual "custom" density factors that can be substituted for the province-wide factors.

- If municipalities are unable to adopt the Annual Weight estimating procedures, it is reasonable to accept municipally estimated tonnages based on their existing informal procedures for the first year of wider-scale system implementation.

The weight estimates used by non-weighing municipalities will be useful but will not be highly accurate during the initial years of wider scale implementation of the reporting system. Improvements in the accuracy of figures may be expected to occur progressively as municipalities either install scales of continually sample weigh the predominant vehicles using the landfill sites.

5. Truck Count Data is Available in Many Municipalities

To help test the ease of wider-scale implementation of the costing system using truck counts, a telephone poll of the prevalence of truck counting was carried out. Twelve additional municipalities of varying sizes were contacted and the availability of truck count or cubic yardage data was discussed. Ten of the twelve had populations in excess of 10,000 people, and six of these municipalities had truck counting data available. Thus, in larger municipalities, 60% may be able to provide truck count or yardage estimates against which density factors can be applied. This indicates the likelihood of good participation in the province-wide application of the costing system.

Based on the success achieved in initiating truck counting procedures and testing the interim density factors, seasonal adjustment factors and annualization factors, wider scale implementation of the costing system is practical in 1980.

Over a period of years, the accuracy of tonnage predictions should improve as each municipality gathers localized weight data and incorporates this into their estimates. In the interim, even if a municipality miscalculates tonnage on a consistent basis each year, there will at least be comparable unit cost trend data in that municipality to help assess performance. The use of the annual weight estimating process is considered an interim measure that can be used to accelerate the implementation of the solid waste costing system.

In the final analysis, however, the introduction of weigh scales at disposal facilities is the most acceptable method of measuring annual tonnage. In the longer term, the Waste Management Branch should encourage major municipalities to install weight scales.

E. AN INTERIM COMPUTERIZED PROVINCIAL REPORTING SYSTEM IS NOW AVAILABLE AND CAN BE MODIFIED FOLLOWING WIDER IMPLEMENTATION

An important aspect of the pilot implementation was the adaption of a computerized provincial reporting system for use in future years. This has been achieved and effective interim monitoring reports provided as illustrated in Appendix V. Adaptation of the program was carried out by Waste Management Branch staff and our consultants working with the computer personnel at the Department of Treasury and Economics, using their utility programs. Due to the nature of the utility programs, data will not be available in the first year of wide-sale implementation on multiple lines for an individual municipality, e.g., for two separate landfill sites. This deficiency

is unfortunate, but should not be allowed to delay the implementation of the system. The basic reporting system is now operative and can be used on an interim basis during wider-scale implementation of the prototype costing system in 1980.

During the pilot implementation program, the detailed municipal input from the nine sample municipalities was processed using the above mentioned program for test purposes. Samples of this data for total waste management costs and collection costs are shown on Table 5 following and in Appendix V for reference. It is evident that the data will be very useful when more municipalities are included for comparison. Municipalities will then be able to compare their collection and disposal costs per ton (in total and by major cost element) with other municipalities in the same size categories and with similar operating characteristics.

Summary statistical information for an additional 102 "collecting" municipalities and 69 "disposing" municipalities (over 10,000 population) was also processed using the program to show samples of the kind of reports (see Appendix V) that could be available in 1980. It was recognized that some inaccuracies were present in the additional municipal data provided by the Department of Treasury and Economics. However, after allowing for inaccuracies, the limited data available for the other municipalities over 10,000 population appeared comparable in terms of order of magnitude.

Since only limited information was available for these extra municipalities that were included in the trial run, the municipalities could not be categorized by operating characteristics as was recommended in our previous report (e.g., contract vs. municipal collection operations). The categories of reporting that should be adopted when custom programming does occur, however, are as follows:

PROVINCIAL MONITORING REPORT
FOR SAMPLE MUNICIPALITIES
7. SUMMARY OF COSTS & REVENUES

MUNICIPALITY	TOTAL POPULATION	SOLID WASTE COSTS AND REVENUES IN DOLLARS: MUNICIPAL COST COLLECTION	MUNICIPAL DISPOSAL COST	LESS: RECOVERY REVENUE	LESS DISPOSAL REVENUE	NET COLL'N AND DISPOSAL COST	SOLID WASTE COSTS AND REVENUES IN DOLLARS PER TON: MUN COLL'N COST PER TON	MUN DISP COST PER TON	RECOVERY REVENUE/TON	IND DISP REV PER TON	SOLID WASTE COSTS AND REVENUES IN DOLLARS PER CUBIC YARD: MUN COLL'N COST DISPOSAL PER CUBIC YAR	COST PER CU YD
		0.	18253500	65800	4789400.	13398300	0	2.91	0	8.32	0	1.15
		4075222.	0.	0.	96674.	4853743.	32.14	0	0	0	12.50	0
		1171365.	984684.	7221.	57492.	2091336	20.70	12.27	6.87	1.46	10.39	4.65
		0.	1934778.	0.	1302812.	631966.	0	5.25	0	6.05	0	4.45
		2071088.	0.	0.	0.	2031988.	22.94	0	0	0	4.75	0.00
			294400.	0.	0	294400	0	3.60	0	0	0	2.71
		1175716.	0	0.	0.	1175716	19.05	0	0	0	13.65	0
		3065743.	1685454	0.	451417.	4299780.	31.54	8.69	0	4.67	7.15	1.76
		30945	28407.	0.	0.	59436.	14.68	7.21	0	0	4.55	1.99
TOTALS:		12370179	23181309	73021	6607600.	28780867	30.18	8.43	6.87	2.44	8.51	1.32

PROVINCIAL MONITORING REPORT
FOR SAMPLE MUNICIPALITIES
3. COLLECTION COSTS

MUNICIPALITY	SCALE OF SERVICE: HOUSEHOLDS COLLECTED	PERCENT HH MUN COLL'D	PERCENT HH CONT COL'D	MUNICIPAL AND CONTRACT COSTS AND REVENUES PER TON: DIRECT LABOUR COST PER TON	EQUIP OP/MAINT COST PER TON	OVERHEAD COST PER TON	CAPITAL COST PER TON	CONTRACT COST PER TON	MUN COL'N COST PER 1000-T-MI	TOT MUN COL'N DISP COST/HH
		0	0	0	0	0	0	0.00	0	19.97
		91	9	7.59	6.50	4.55	2.10	11.64	0	35.25
		0	100	0	0	0	0	29.70	0	48.81
		0	0	0	0	0	0	0.00	0	13.97
		0	100	0	0	0	0	22.94	0	22.63
		0	0	0	0	0	0	0.00	0	9.74
		90	10	25.38	6.43	7.35	1.93	5.60	0	37.59
		100	0	12.46	7.57	4.76	2.10	0.00	0	70.13
		0	69	0	0	0	0	11.68	0	28.48
TOTALS:			9.41	21.41	6.94	4.57	2.10	23.58	0	0

- by municipal size,
- by collection frequency,
- by operator (e.g., municipal vs. contractor),
- by crew size, and
- by municipalities with and without weight information.

Categorization of municipalities in the provincial report by these criteria will make the analysis of costs and performance easier for municipal and branch staff.

In future, the programs should allow for multiple lines of cost and performance data for individual municipalities so that comparative landfill site, transfer station, or incineration station data is prepared for individual facilities within each municipality. This additional programming work should be supervised by Waste Management Branch staff once their data processing and information section becomes established and all of the branchs' systems requirements have been prioritized.

F. WASTE MANAGEMENT BRANCH STAFF CAN IMPLEMENT THE COSTING SYSTEM ON A WIDER SCALE

One of the key elements of the pilot implementation was to develop expertise in the use of the prototype costing system within the Ontario Ministry of the Environment. Although regional staff were not involved in the assignment due to other work priorities, Waste Management Branch staff actively participated. Key areas of their involvement included:

- introducing the system to municipalities,
- reviewing the quality of municipal input,
- assessing the value of the provincial reports, and
- adapting the computerized provincial reporting system.

Based on the work performed by branch staff, we believe that a reasonable level of expertise now exists within the Waste Management Branch. On this basis, it is practical to expand implementation of the costing system in 1980 to cover all municipalities with populations in excess of 10,000 within the Province of Ontario on a full scale reporting basis. These larger municipalities should have the necessary staff resources to enable completion of the data forms and subsequently be in a position to use the data to improve performance and control. The smaller municipalities may be converted to the system with a short form of reporting at some time in the future if the Branch or other provincial bodies require complete provincial coverage by the system.

In Section II of this report the key steps taken in the pilot implementation are reviewed and our assessment of the practicality of wide scale implementation of the system is indicated. Section IV following summarizes the results of the pilot implementation and also summarizes the benefits of expanded implementation in 1980, to municipalities and to the provincial policy-making bodies.

IV. WIDE SCALE IMPLEMENTATION OF THE COSTING SYSTEM WILL BE PRACTICAL AND BENEFICIAL

In the preceding sections of this report the various requirements for wider scale implementation of the costing system were reviewed. Some of the key areas where positive results were achieved that will help further implementation were as follows:

- The majority of municipalities participated willingly and provided reasonably accurate information.

- The solid waste density factors that were developed can easily be applied to sample truck count data on an interim basis.

- Truck count or yardage data is probably available in the majority of larger municipalities.

- A computerized provincial reporting program is available.

- Waste Management Branch staff are trained to expand implementation of the prototype costing system.

The above summary indicates that wide scale implementation of the costing system is practical. The key benefits that we see being achieved are set out below.

A. MUNICIPALITIES CAN MEASURE THEIR COMPARATIVE PERFORMANCE

Several advantages of the full scale involvement of 107 large municipalities across the province are envisaged as follows:

- The provincial report will provide comparative cost and operating performance data that will help municipalities assess their performance in relation to their peers, e.g., collection cost per ton, man hours per ton landfilled, differential costs related to changes in service level, etc.

- If copies of detailed data forms are supplied to a municipality on request for the other municipalites in similar categories, it can compare its detailed operating characteristics with others and seek improvements in performance.

- Dialogue between municipal engineering groups will be encouraged and this should generate a higher level of sharing of efficient solid waste management practices. For example, how did a certain municipality move from three-man to one-man packers, how was the change explained to the personnel involved, and what were the cost savings?

- Weighing municipalities can use the standard density factors to compare their own equipment and man hour performance with other weighing municipalities.

- Non-weighing municipalities will have an interim basis for measuring collection and landfill site performance, e.g., cost per ton landfilled.

- By having each municipality carry out the process of compiling data, and preparing the data forms, certain questions may be raised or statistics may be developed that raise questions on performance in the municipality even before comparisons with other municipalities are made.

- If municipalities adopt all or part of the municipal control manual, there should be benefits from planning and monitoring their operations on a week-to-week basis that should lead to better manpower and cost control.

- Non-weighing municipalities will be able to use the estimated landfill tonnages to measure the efficiency of compaction at the site after the annual survey of "cubic yards of site utilized" is prepared. Based on solid waste generation per capita and population trends, they should also be able to forecast the life of landfill sites with greater reliability.

B. DATA AVAILABLE TO THE PROVINCE AND THE POLICY MAKERS WILL BE ENHANCED SUBSTANTIALLY

As well as providing municipalities with useful comparative performance and cost data to improve efficiency, the provincial bodies will also derive benefits from the wider scale implementation of the costing system, as follows:

- A data base will be available of solid waste collection and disposal performance, and service levels, for use in the preparation of feasibility studies for alternate waste processing proposals.

- The Waste Management Branch will be able to assist municipalities with suggestions on improving cost efficiency or suggest which other municipalities with more efficient operations can be of help.

- Identification of major municipalities that do not charge dumping fees for industrial users because of lack of weigh scales can lead to Branch guidance on the preparation of feasibility studies to provide such weigh scales as a basis for initiating user charges.

- Data will be available in a standard form that can be issued to tenderers for new recycling plants so that they use comparable data for feasibility studies (e.g., transfer station or landfill costs per ton).

- By reviewing the provincial monitoring report, Branch staff may be able to see which cost/operating areas require priority attention by them to help municipalities reduce costs or deal with impending changes (life of landfill). Also, if major disparities in municipal collection cost are evident, training seminars on efficient collection practices could be initiated.

- When solid waste generation statistics are available for the whole province, the physical and cost impact of changing legislation may be assessed on a year to year basis. A reduction in, say, bottles, in waste may be discernable in the tonnage trends and can be related to province wide landfill site life.

The full implementation of the costing system should bring these benefits over a period of years, as the quality and consistency of data improves. Based on these benefits and a potential for cost reduction in the province of more than $10 million per annum, full scale implementation of the costing system is recommended in municipalities of over 10,000 people in 1980 for the 1979 fiscal year. The Branch may consider implementation for the smaller municipalities at a later date using a short form of return if real benefits can be predicted.

In the final analysis, even with provincial support and guidance, it will rest with individual municipalities to improve operating performance and cost controls on a weekly basis. Municipalities will no doubt strive for cost reduction that does not seriously impact service levels. Achievement of these gradual improvements in performance depends upon municipal control of operations using techniques and reports similar to those suggested in the municipal cost control manual included in our previous study for the Board. The terms of reference of the pilot implementation assignment did not specifically include a detailed review of the feasibility of province wide adoption of the cost control manual or similar operating mechanisms. The Waste Management Branch and/or Advisory Board may wish to implement the approach set out in the manual on a test basis and subsequently assist all large municipalities in adopting this approach. The detailed cost and performance control mechanisms would then be in place to help all larger municipalities to become more cost effective.

V. IMPLEMENTATION IN 148 MUNICIPALITIES IS PRACTICAL FOR 1979 DATA

If agreement is reached at the Waste Management Branch to dedicate a person to implement the costing system it will be practical to approach the 148 major municipalities in Ontario for full scale implementation in 1980. A fall 1979 implementation start will be preferrable to enable better annual weight estimating starting in the new year. The key steps and their timing required for wide scale implementation will include the following:

• Letter issued by Waste Management Branch to all municipalities explaining the key results of the pilot study and the anticipated benefits of wide scale implementation. Letter to indicate the planned involvement of larger (over 10,000 population) municipalities in the initial years. Examples of the sample 1978 provincial data to be included with the letter.	October/November 1979
• Municipal input forms given final approval by the Waste Management Branch, printed and mailed out to municipalities with an instruction booklet. This timing will give municipalities advance notice of the data required.	November 1979
• Meetings arranged with regional and other second tier municipalities (to include all major municipalities above 10,000 in population).	December 1979
• Meetings held with municipalities and slide presentations made by Branch staff person. Key municipal staff identified and an assessment made of probable participation.	January to March 1980
• Issue truck counting procedures, density factors and seasonal factors to the non-weighing municipalities.	January 1980

• Telephone follow-up to municipal staff to ensure input forms and procedures are understood, and that data can and is being collected.	February and March 1980
• Edit the quality and completeness of municipal input. Telephone follow-up of question areas and municipal visits if necessary. Input municipal data into computer files.	April to July 1980
• Process computerized Provincial Reports including edit routines. Telephone follow-up of query areas and resubmission of data to computer files.	April to July 1980
• Produce final Provincial Report and issue to all municipalities.	August 1980
• Analysis of Provincial Report data by Waste Management Branch staff. Review of high cost or low efficiency areas and discussion with municipal staff as appropriate. Arrange training and information meetings for selected municipalities to explain key areas for cost reduction or efficiency improvement, and proposed methods for achieving them.	September to December 1980

The above steps summarize the necessary activities to be carried out in the wide-scale implementation of the solid waste costing system. These tasks will have to be planned in more detail by the Waste Management Branch

project manager prior to the initiation of the implementation program. The documentation in this report and the experience gained in the pilot implementation will be useful in the preparation of the 1980 implementation plan. The time plan suggested is achievable if this project is given sufficient emphasis and the recommended full-time project manager is assigned. It is desirable to achieve the recommended schedule so that the data are released in a timely fashion, and so that the unabated continuation of the project is evident to all municipal participants.

To achieve the desired cost efficiencies in sold waste management it will be very important for the Waste Management Branch staff to carry out the suggested analytical and follow-up efforts working with municipalities in subsequent years.

VI. CONCLUSION

The pilot implementation has been successful. Most municipalities have co-operated and the survey of the results has been acceptable. The municipalities involved have endorsed the usefulness of the comparative data and the majority support wider-scale implementation. Procedures have been established for the determination of annual waste tonnage handled by non-weighing municipalities based on truck counting and use of density and seasonal adjustment factors. Waste Management Branch staff have participated in the adaptation of an interim computerized provincial cost reporting process which is now operational. The solid waste management cost accounting system should be implemented in all municipalities over 10,000 population in 1980. The active participation and co-operation of municipal and Ministry staff was appreciated.

Currie, Coopers & Lybrand Ltd.

CURRIE, COOPERS & LYBRAND LTD.

RECOMMENDED TIME-PHASED PLAN FOR PILOT IMPLEMENTATION IN 1978

1. INITIATE AND SETTLE WORKING ARRANGEMENTS WITH SIX SAMPLE MUNICIPALITIES, THREE ADDITIONAL WEIGHING MUNICIPALITIES, ONE TO CONDUCT THE SAMPLE WEIGHING PROGRAM AND TEIGA FOR THE CONDUCT OF THE IMPLEMENTATION PLAN

   A. Meet with the Board and arrange contact with six sample municipalities to obtain formal clearance

      - to obtain 1977 cost and operating data, and
      - to have a Ministry representative perform sample truck counts for two weeks in April and two weeks in July, 1978, if the community does not weigh (consider using students or part-time employees).

   B. Select three additional weighing municipalities, one operating a transfer station and, if possible, one operating an incinerator to add to the sample.

      - Contact and obtain co-operation to provide 1977 cost and operating data and establish a work timetable.

   C. Select one weighing municipality in which the sample weighing program is to be carried out for two weeks in April and two weeks in July, 1978, which has a wide range of truck types using its disposal site.

      - Contact and obtain co-operation to sample weigh vehicles in and out, using Ministry staff to collect and compile the data.

   D. Formalize arrangements with TEIGA to develop, test, and operate the automated provincial monitoring system as recommended.

      - Establish work timetable, and arrange for time availability of service bureau programmer, TEIGA resource needed to co-ordinate the systems work, and key punch operators.

2. DEVELOP A METHOD FOR, AND SUPERVISE CONDUCT OF THE SAMPLE WEIGHING PROGRAM TO DERIVE TRUCK DENSITY FACTORS TO ENABLE CONVERSION OF TRUCK COUNT DATA TO WEIGHT AND VOLUME FOR MUNICIPALITIES WITHOUT WEIGHSCALES

   A. Develop method, prepare instructions and data collection forms and test procedures at selected weighing municipality and modify if required.

   B. Work with Ministry's regional representative and part-time resource on site to ensure that quality of data collected is satisfactory.

   C. Analyze data compiled and summarized by Ministry staff, derive weight, volume and density factors and test statistical reliability.

D. Review results, and if possible, compare with data available in weighing communities and that derived from other sampling programs to test reliability of density factors.

E. Obtain monthly weights from enlarged sample of weighing municipalities to estimate monthly variation in waste generation.

3. CONDUCT TRAINING PROGRAM FOR REGIONAL MINISTRY STAFF AND PART-TIME STAFF CARRYING OUT THE WORK AND INTRODUCE THEM TO THE MUNICIPAL OFFICIALS THEY WILL BE WORKING WITH IN NINE SAMPLE MUNICIPALITIES

A. Arrange with the Ministry which regional staff will be supervising the municipal data collection, sample truck counting, sample weighing and other activities and arrange a general timetable for their participation in the project and for the hiring of part-time help for the sampling programs.

B. Prepare a training program to

- instruct Ministry staff how to collect and adjust cost and operating data and, where necessary, conduct sample truck counts in non-weighing municipalities. The use of the municipal input forms will be fully described as well as relevant cost adjustment forms.

C. Conduct training program described above.

D. Train one Ministry staff located in Toronto whose responsibility will be to

- conduct the sample weighing program,
- derive truck weight, volume and density factors,
- help prepare the municipal input forms for automated processing of the provincial monitoring report,
- help prepare all provincial monitoring reports manually for parallel testing with the automated system,
- help prepare the manually produced provincial monitoring reports for special processes, and
- assist in supervising the development and testing of the automated reporting system.

E. Visit nine municipalities with Regional Ministry staff to introduce them to municipal officials and explain what is to be accomplished by their work. Agree on a work plan, and commence the data collection program of physical and operating information.

4. SUPERVISE THE COLLECTION OF FINANCIAL AND OPERATING INFORMATION BY MINISTRY STAFF IN NINE MUNICIPALITIES

A. Review information obtained and assist in ensuring that physical data is collected fully and properly and that most frequently incoming types of trucks at disposal sites are known.

B. Review 1977 financial information to ensure reasonable accuracy with particular attention to correct treatment of reporting anomalies, equipment rental and capital costs.

C. Meet with Regional representatives to review initial study and suggestions for modification.

D. Prepare review and analysis of all 1977 financial and operating data prepared on municipal input forms and manually prepared in the format of the provincial monitoring report.

5. INITIATE AND SUPERVISE TRUCK COUNTING PROCEDURES IN FOUR MUNICIPALITIES WITHOUT WEIGHSCALES

A. Work at each non-weighing disposal site with Ministry supervisory staff to ensure that procedures are carried out correctly for the first day of truck counting and that counts are summarized correctly.

B. Review determination of initial weight and volume estimates for the year 1977 based on the application of truck density factors obtained from the sample weighing program against the sample truck counts using the approved work sheets.

C. Meet with regional representatives to modify where necessary.

6. WITH THE AID OF A MINISTRY RESOURCE, SUPERVISE THE DEVELOPMENT, TESTING AND OPERATION OF THE AUTOMATED REPORTING SYSTEM AT TEIGA

A. Work with TEIGA's co-ordinator of systems to prepare detailed user specifications based on the consultant's report.

B. Test operation of the program with simulated data against a manually prepared provincial report and ensure that municipal input forms are completed and coded correctly.

C. Modify, retest and ensure that program is operational for use when 1977 data is to be processed for nine sample municipalities.

D. Ensure that the Ministry resource supervises 1977 data coding correctly for input into the automated system.

E. Analyse outputs of provincial monitoring report to ensure reasonableness of data reported.

7. EVALUATE OPERATION OF THE MUNICIPAL INPUT FORMS AND AUTOMATED REPORTING SYSTEM, ANALYZE DATA FOR NINE MUNICIPALITIES FROM THE PROVINCIAL MONITORING REPORT AND RECOMMEND MODIFICATIONS FOR USE IN THE FOLLOWING YEARS

A. Evaluate operation of the municipal input forms and automated reporting system.

B. Interpret data for nine municipalities from the provincial monitoring report.

C. Recommend modifications to the system for use in later years.

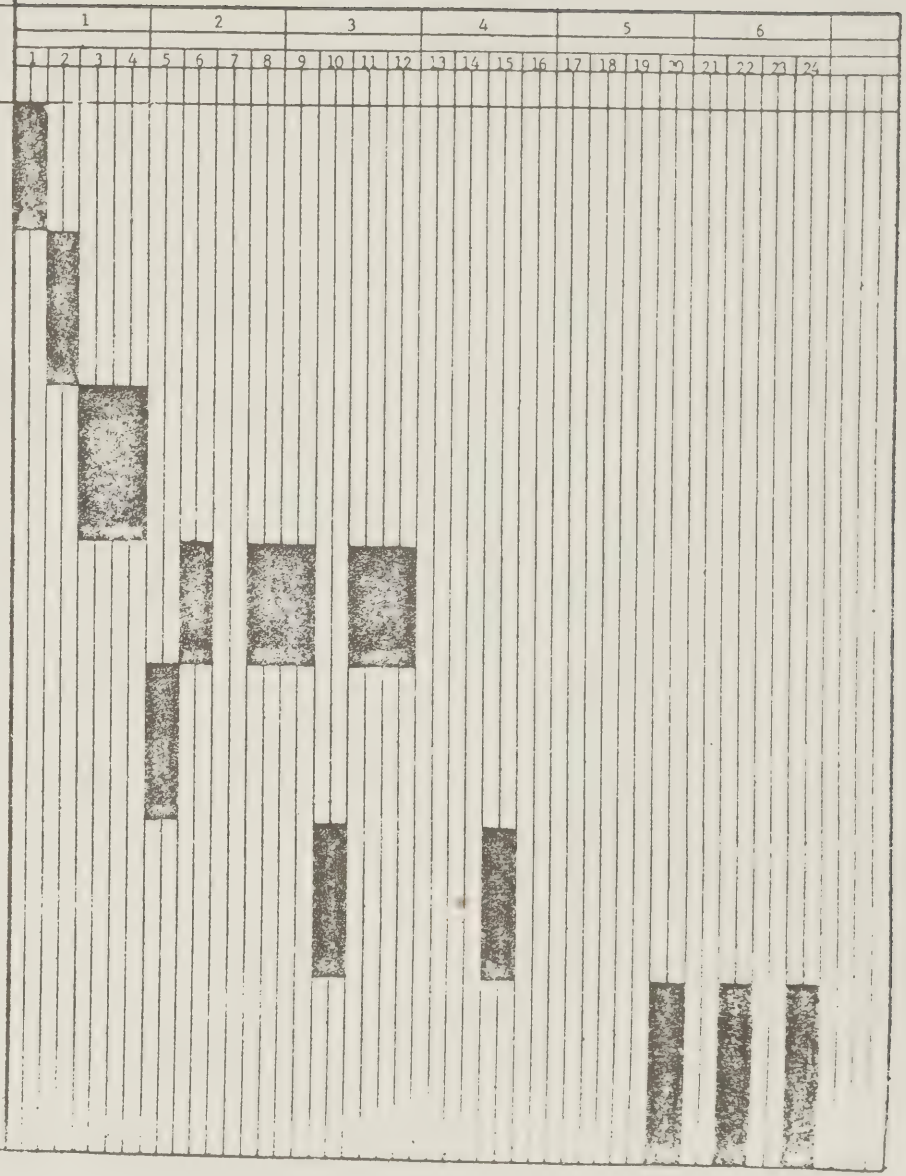
D. Prepare a brief draft report for submission to the Board.

E. Review report with the Board.

F. Modify and submit final report to the Board.

RECOMMENDED TIME-PHASED PLAN FOR PILOT IMPLEMENTATION IN 1978

REFERENCE ELEMENT		MAJOR ELEMENT
1		Initiate and settle working arrangements with six sample municipalities, three additional weighing municipalities, one municipality to conduct the sample weighing program and TEIGA for the conduct of the implementation plan.
2		Develop a method for and supervise the conduct of the sample weighing program to derive truck density factors to enable conversion of truck count data to weight and volume for municipalities without weighscales.
3		Conduct a training program for Ministry staff carrying out the work and introduce them to the Municipal officials they will be working with in the nine sample municipalities.
4		Supervise the collection of financial and operating information by Ministry staff in the nine municipalities.
5		Initiate and supervise truck counting procedures in four sample municipalities without weighscales using the forms developed in the municipal control manual.
6		In conjunction with a Ministry resource, supervise the development, testing and operation of the automated reporting system at TEIGA.
7		Evaluate the operation of the municipal input forms, automated reporting system, analyze data reported for the nine municipalities for the provincial monitoring report and recommend modifications for use in following years.



DETAILS OF TRUCK WEIGHING PROGRAM, DENSITY FACTORS, SEASONAL FACTORS AND THE STATISTICAL ANALYSIS

TABLE OF CONTENTS

SECTION	
A	TRUCK WEIGHING FORM, PROCEDURES AND EXAMPLES OF RESULTS
B	DENSITY FACTORS BY SITE, TYPE OF VEHICLE, AND "PER LOAD" FACTORS
C	ANALYSIS OF A.M. VERSUS P.M. DENSITY FACTORS
D	SEASONAL WASTE FACTORS, AND SEASONAL DENSITY ADJUSTMENT PERCENTAGES
E	TESTING OF DENSITY AND SEASONAL FACTORS
F	STATISTICAL ANALYSIS OF DENSITY FACTORS AND PREDICTABILITY

TRUCK WEIGHT SAMPLING PROCEDURES

One key aspect of the pilot implementation of the solid waste costing system was the development of density factors for use in non weighing municipalities. Development of the density factors required that sample truck weight data be collected from weighing municipalities. To collect the data, a simple procedure and recording form were developed as shown on pages 2 and 3, following.

The key data collected at six scale locations in February, 1979, and three scale locations in May and June, 1979, was as follows:

- Operator category - municipal, contractor working for a municipality, or private user.
- Waste category - loose or compacted.
- Vehicle type - side loading packer, roll-off box, etc.
- Vehicle capacity - twenty cubic yards, twenty-five cubic yards, etc.
- Weight of load.
- Vehicle reference number.
- Time of load.
- Type of waste - residential, commercial or industrial.

The forms and basic procedures for collecting the truck weight data were explained to the scalemen at each site and were readily comprehended. The neatness of the figures varied somewhat, but the data data recorded appeared reasonably accurate.

As well as an example of the blank form, a sample from an actual site is included to aid the reader and to help with further truck weight samples that can be undertaken by the Waste Management Branch in the future.

TRUCK WEIGHT SAMPLING PROCEDURE

Objective

The object of carrying out this sampling procedure is to determine an average weight per cubic yard of residential or commercial/industrial solid waste. These densities will then be used by non-weighing municipalities to calculate the annual solid waste tonnages.

Procedure

1. Collecting Basic Data

- The weigh tickets should already contain the majority of the basic data for each incoming load.

  e.g. Registration number
  Operator
  Net weight of load

- With simple additional coding, the other data can be entered on the weigh ticket, and then summarized later.

  e.g. Cubic Yards
  Fleet number
  Vehicle type -

Front Loading Packer	FLP
Rear Loading Packer	RLP
Side Loading Packer	SLP
Lugger Box	LB
Stake Truck "X" Tons	STP
Misc. 1/2 Ton or car	M
Roll Off	RO
Stationary Packer	SP
Tractor Trailer	TT
Flat Bed	FB
Single Axle	SA
Dual Axle	DA

- Note P (Compacted) or L (loose) on the ticker.

- For the time of the load, enter the hour only

  e.g. 7 = 7.10 or 7:45 (i.e., between 7:00 A.M. and 8:00 A.M.)
  8 = 8.30 or 8:32, etc.

- The type of waste; use R for residential, C for commercial, I for industrial, A for apartment, or N/A if unknown or not available

- Enter as much data on the weigh slip as is practical in the time available. The operator, weight and yardage, and packed or loose data is the most important to record.

2. Summarizing the Data for Each Day

- Blank forms are attached.
- Use pencil for the summaries so cubic yard capacities can be confirmed with municipalities.
- Separate forms should be used for
  - each municipality using the site,
  - private contractors working for a municipality, and
  - private collectors.
- Segregate loose versus compacted waste.
- Segregate each vehicle type by size.

  e.g. a separate sheet for fourteen yard lugger boxes
  a separate sheet for twenty yard rear-loading packers, etc.
- Try to complete the summaries daily while the information is fresh, before the tickets are removed from the scale house.

WASTE MANAGEMENT BRANCH
TRUCK DENSITY SAMPLE

MUNICIPALITY _____

SCALE LOCATION _____

PREPARED BY _____

DATE _____

DESCRIPTION OF USER:	MUNICIPALITY OF ☐ _____	PRIVATE CONTRACTOR FOR MUNICIPALITY OF ☐ _____	PRIVATE CONTRACTORS ☐	OTHER

VEHICLE REG. #	OWNED BY	FLEET #	VEHICLE TYPE	CUBIC YARD CAPACITY	LOOSE OR PACKED	LOADS IN KG'S											
						# 1	TIME TYPE	# 2	TIME TYPE	# 3	TIME TYPE	# 4	TIME TYPE				

APPENDIX II
SECTION A
Page 4

WASTE MANAGEMENT BRANCH
TRUCK DENSITY SAMPLE

MUNICIPALITY REGION OF PEEL
SCALE LOCATION 1875 N SHERIDAN WAY
PREPARED BY W. VINCENT
DATE Feb 12/79

DESCRIPTION OF USER:	MUNICIPALITY OF ☐	PRIVATE CONTRACTOR FOR MUNICIPALITY OF MISSISSAUGA ☑	PRIVATE CONTRACTORS ☐	OTHER

VEHICLE REG. #	OWNED BY	FLEET #	VEHICLE TYPE	CUBIC YARD CAPACITY	LOOSE OR PACKED	LOADS IN KG'S (435.) # 1	TIME TYPE	# 2	TIME TYPE	# 3	TIME TYPE	# 4	TIME TYPE				
↓	MUNISAN	904	R.P	20	P	12000	R	11800	R								
↓	MUNISAN	911	R.P	20	P	13400	R	13000	R	1070	R						
↓	MUNISAN	462	R.P	25	P	16000	R	15800	R	1470	R						
↓	MUNISAN	421	R.P	20	P	13800	R	13500	R	2000	R						
↓	MUNISAN	909	R.P	20	P	10300	R	11600	R	950	R						
↓	MUNISAN	906	R.P	20	P	16000	R	15200	R								
↓	MUNISAN	920	R.P	20	P	13500	R	13900	R	2000	R						
↓	MUNISAN	901	R.P	20	P	11400	R	11200	R								
↓	MUNISAN	464	R.P	25	P	16000	R	15700	R	1470	R						

APPENDIX II
SECTION A
Page 5

DENSITY FACTORS WERE CALCULATED

Using the sample truck weight data collected from six scale locations, density factors were computed. They were calculated for each vehicle type and size, and segregated further by operator category and type of waste (loose or compacted).

The factors were calculated in kilograms per cubic yard of vehicle capacity. This unit of measure was used because four of the six sites were using metric weights, but vehicles are still rated in cubic yards. Conversion of the "cubic yard" density factors to cubic metres will be relatively simple, and should be undertaken by the Waste Management Branch when collection vehicles are rated in cubic metres by the manufacturers.

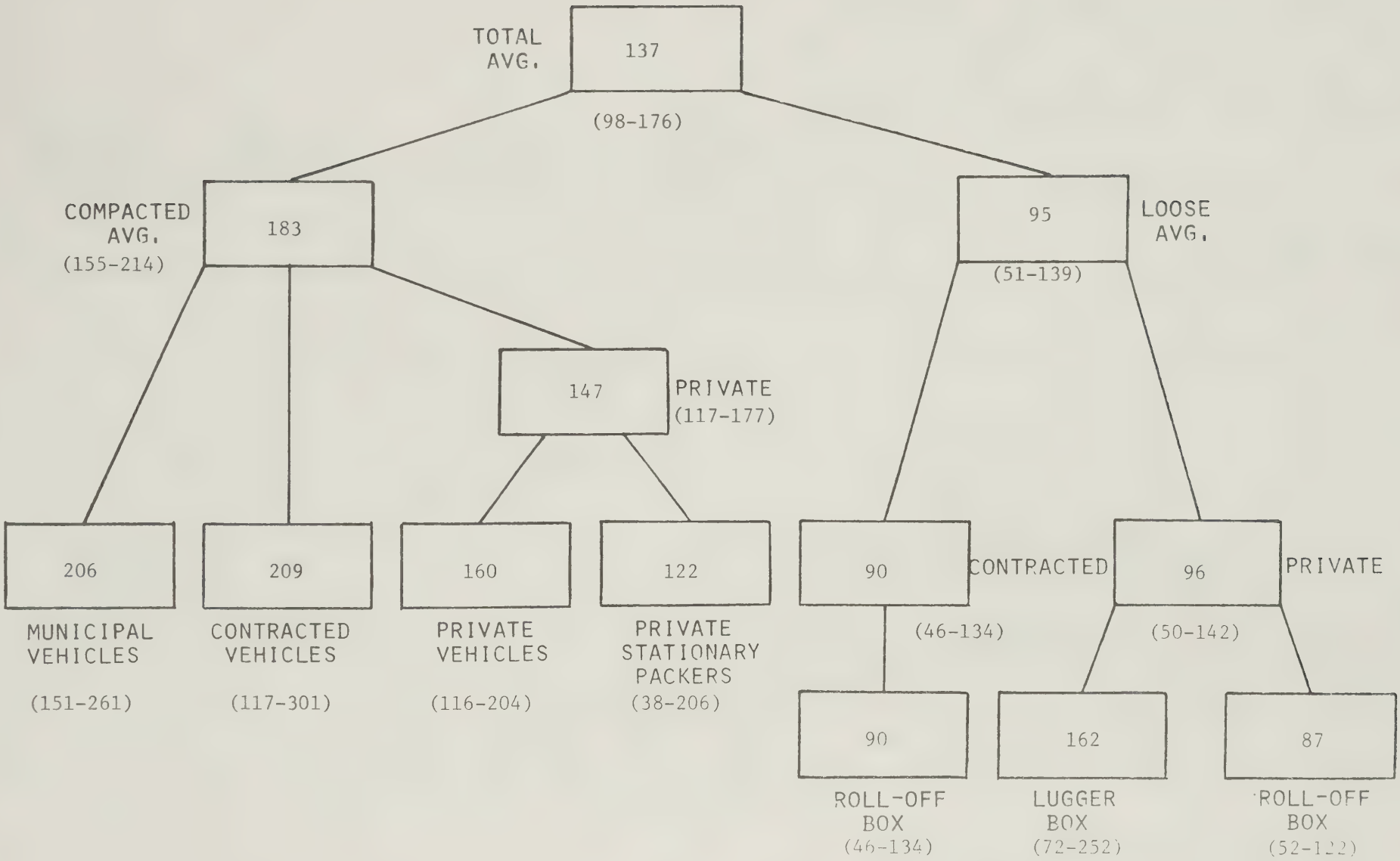
When all the density factors were completed for each site, the data was displayed in a simple hierarchical format that facilitates visual comparison of operators, waste type, and vehicle type densities. The results from the six sites were then averaged and displayed on a similar graphic summary. Tables 1 to 6 show the displays of loose and compacted waste. Tables 7 to 12 show the displays of compacted waste broken out into more detail by vehicle type and then size.

The density figures that were collected for miscellaneous vehicles are not included in the graphic displays since the prolific number of vehicle types and sizes could not be summarized in the same format. The key figures that will be of use in wider scale implementation of the costing system were extracted from the analysis, however, and are listed on Table 13 for future reference. The detailed analysis sheets will also be available for use by the Waste Management Branch when further weight samples are taken in the future, to refine the density factors.

Once all the density factors were summarized and averaged between sites, a statistical analysis was carried out to test the predictability of the densities. This analysis is described in Section F.

COLLECTION WASTE DENSITY-SAMPLING RESULTS

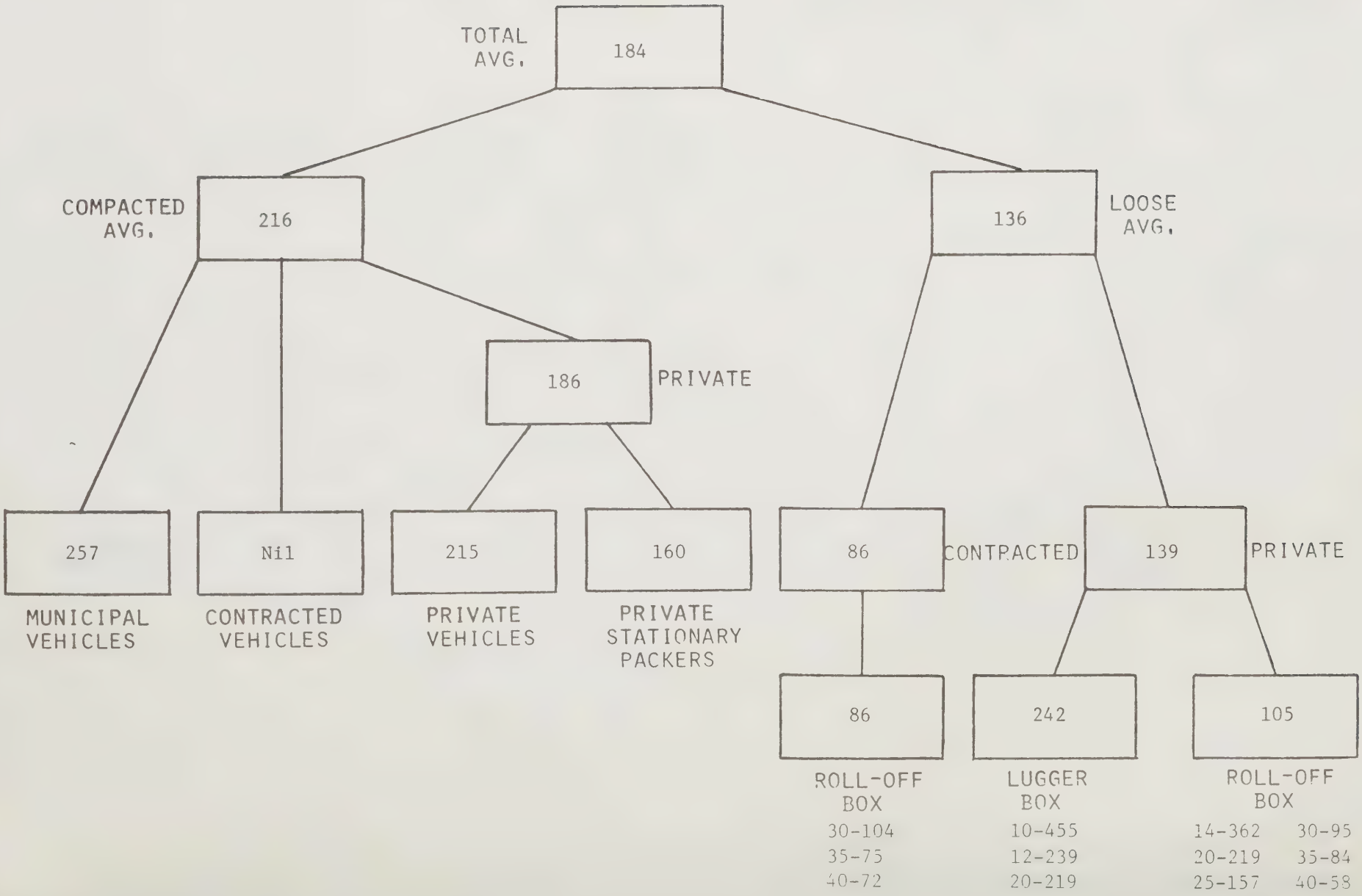
5 SITES



APPENDIX II
SECTION B
Table 1

COLLECTION WASTE DENSITY-SAMPLING RESULTS

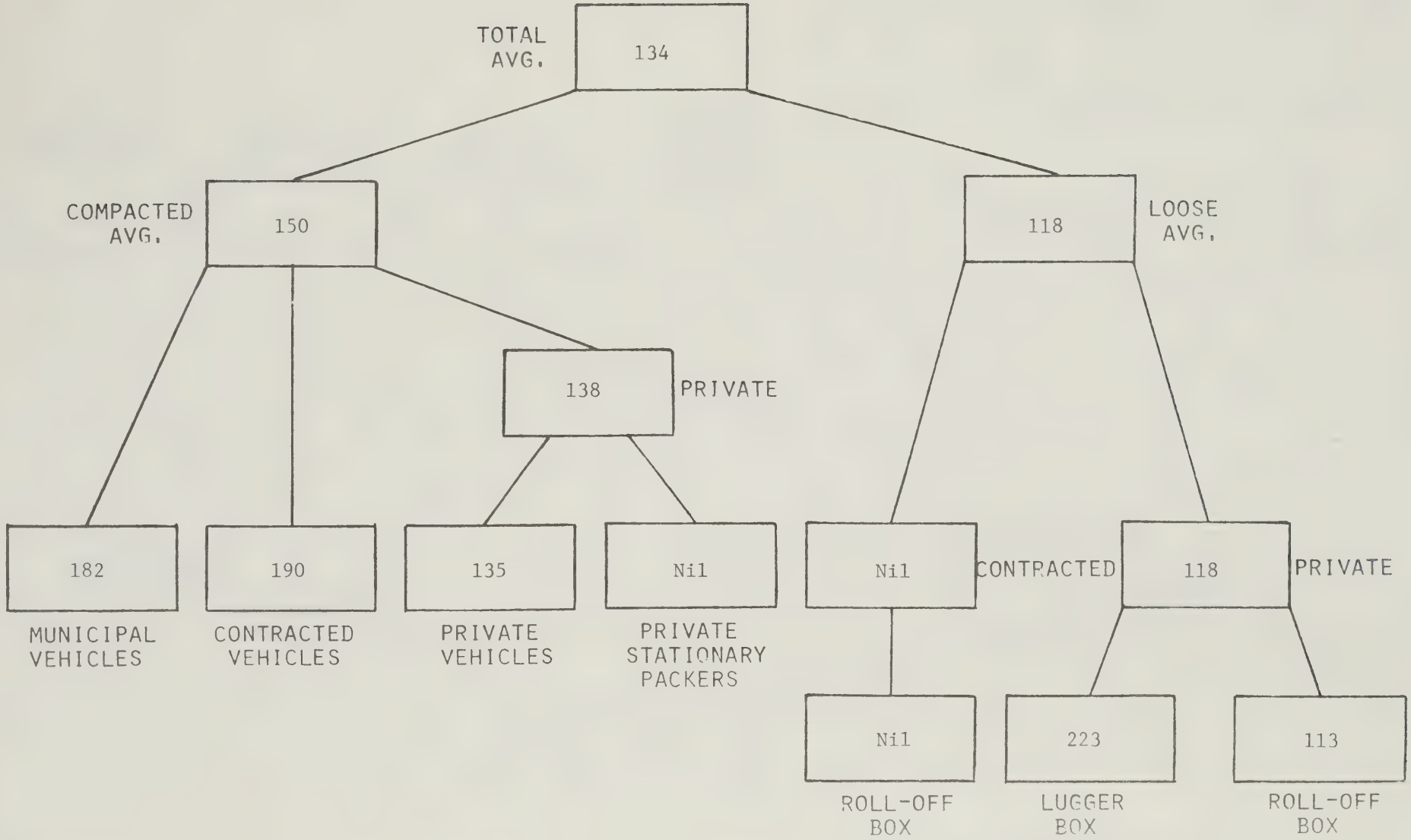
London SITE



APPENDIX II
SECTION B
Table 2

COLLECTION WASTE DENSITY-SAMPLING RESULTS

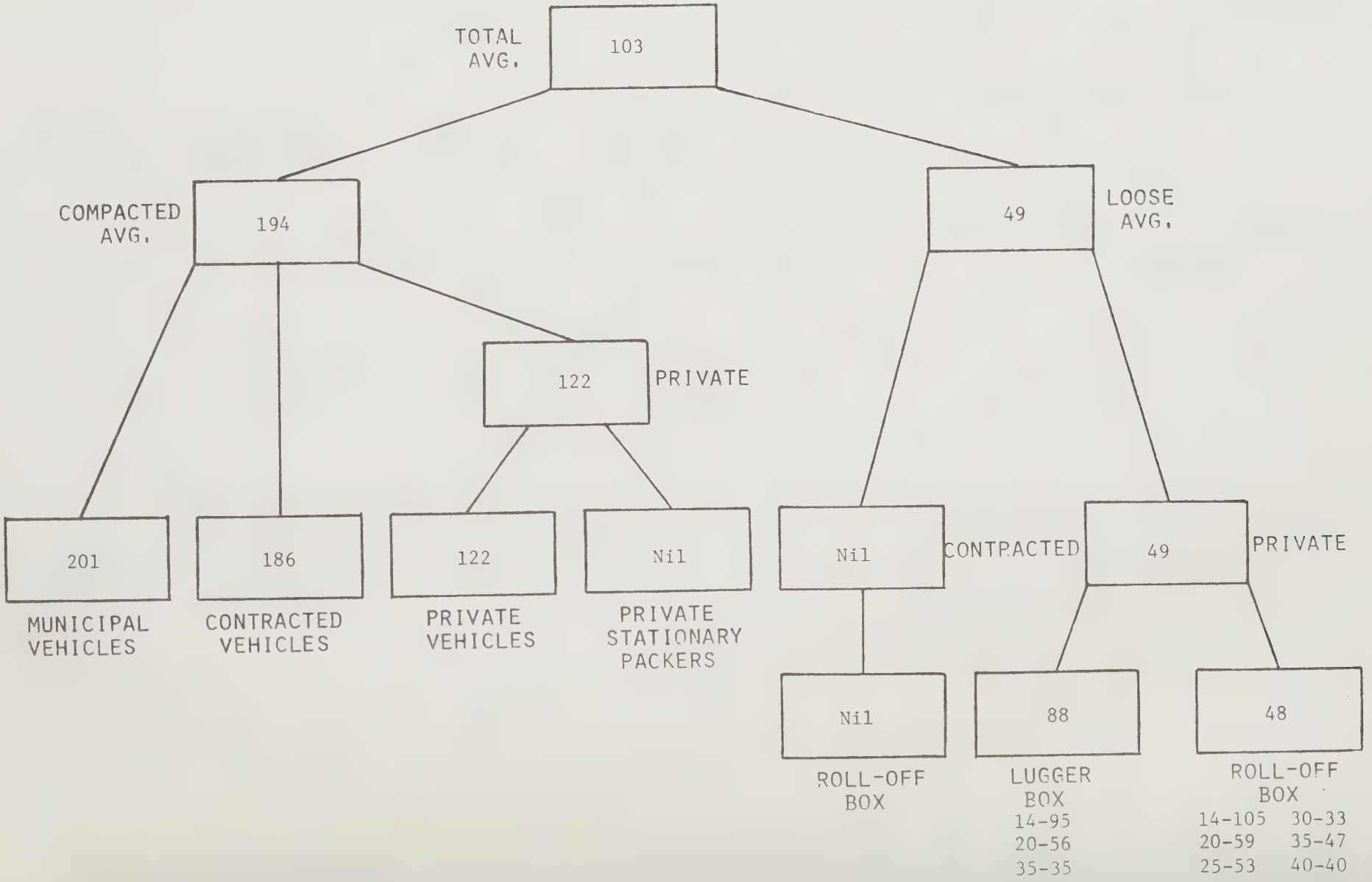
Beare Rd. SITE



APPENDIX II
SECTION B
Table 3

COLLECTION WASTE DENSITY-SAMPLING RESULTS

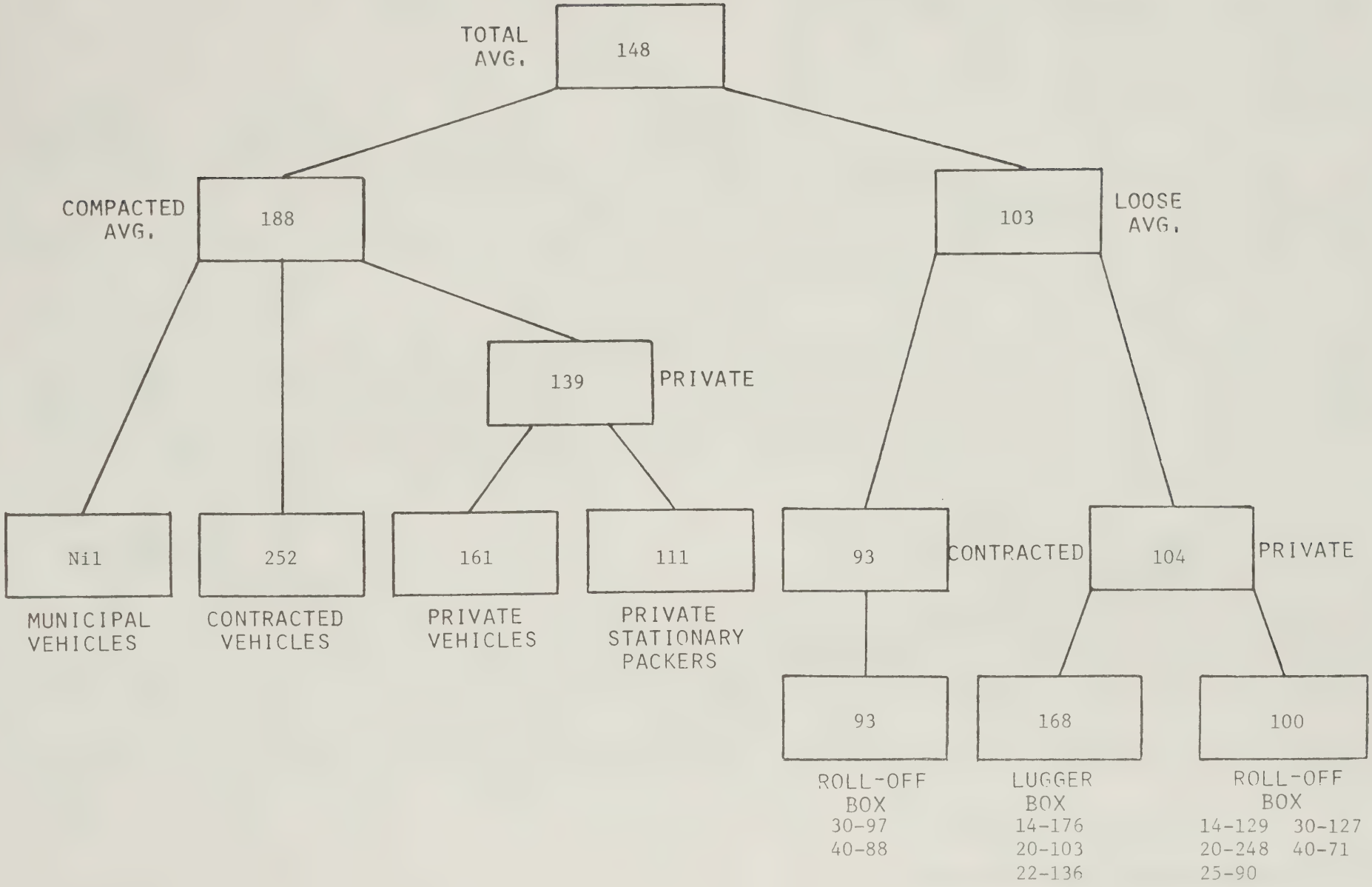
Ingram Dr. SITE



APPENDIX II
SECTION B
Table 4

COLLECTION WASTE DENSITY-SAMPLING RESULTS

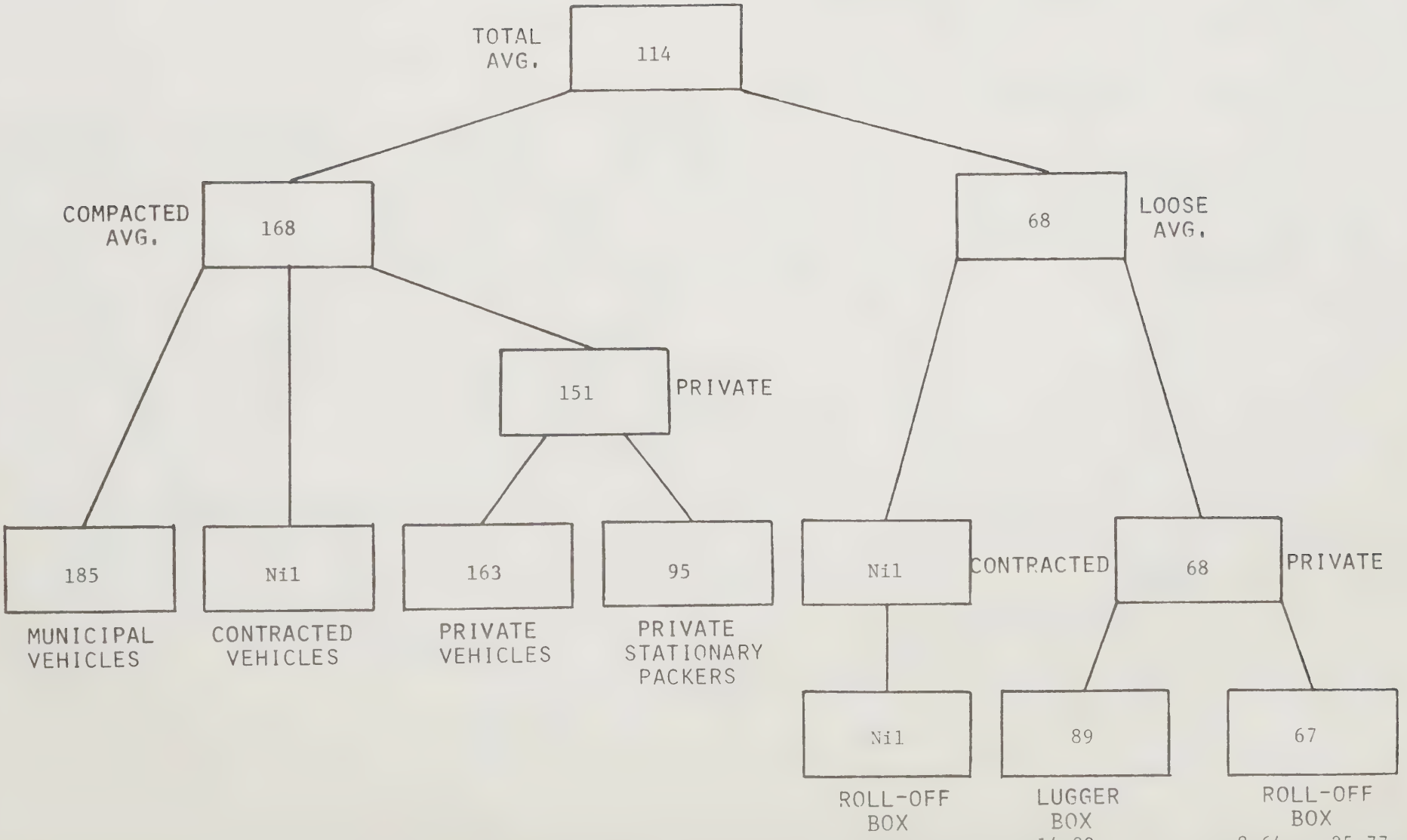
Erin Mills SITE



APPENDIX II
SECTION B
Table 5

COLLECTION WASTE DENSITY-SAMPLING RESULTS

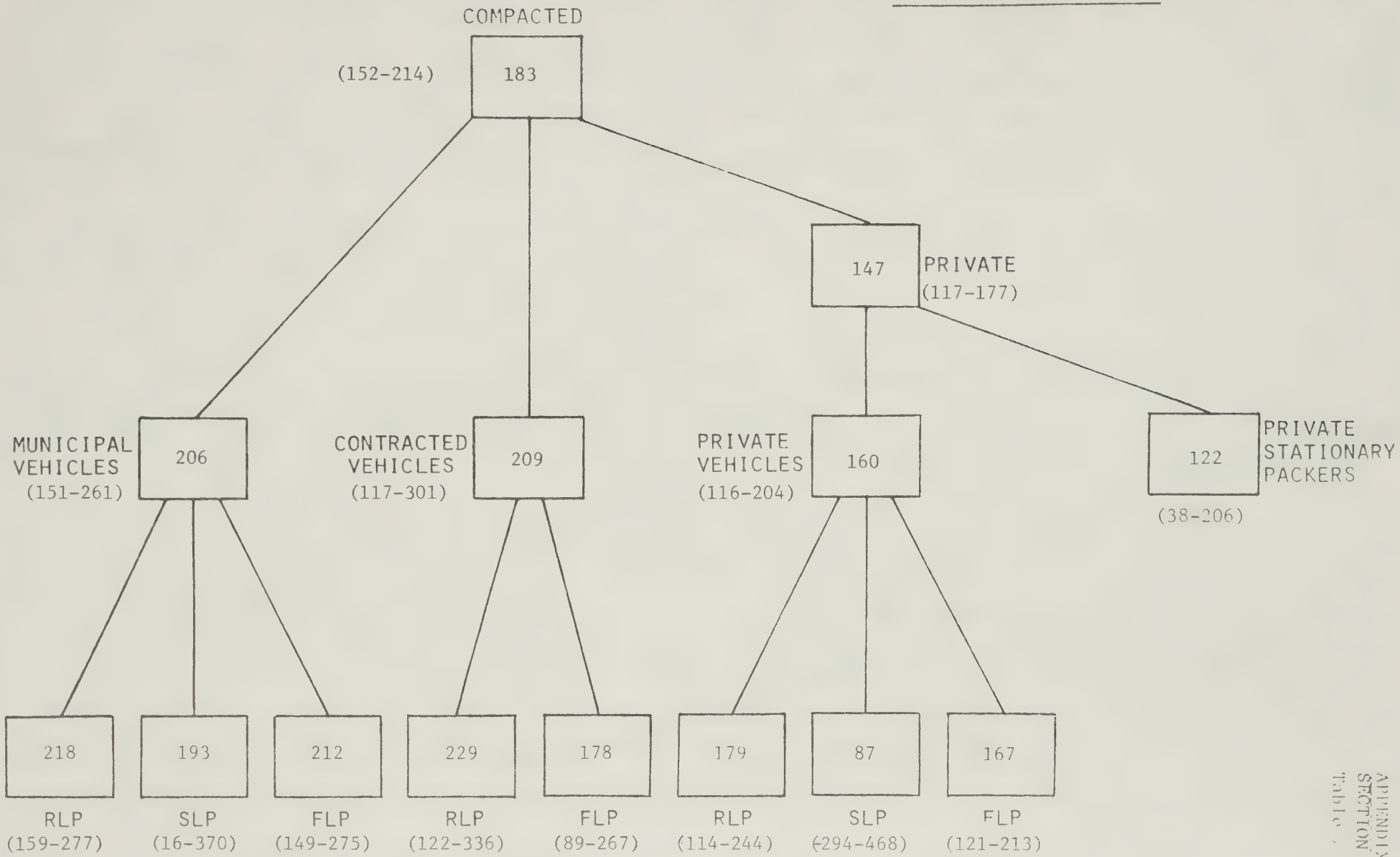
Brock West SITE



APPENDIX II
SECTION B
Table 6

COLLECTION WASTE DENSITY-SAMPLING RESULTS

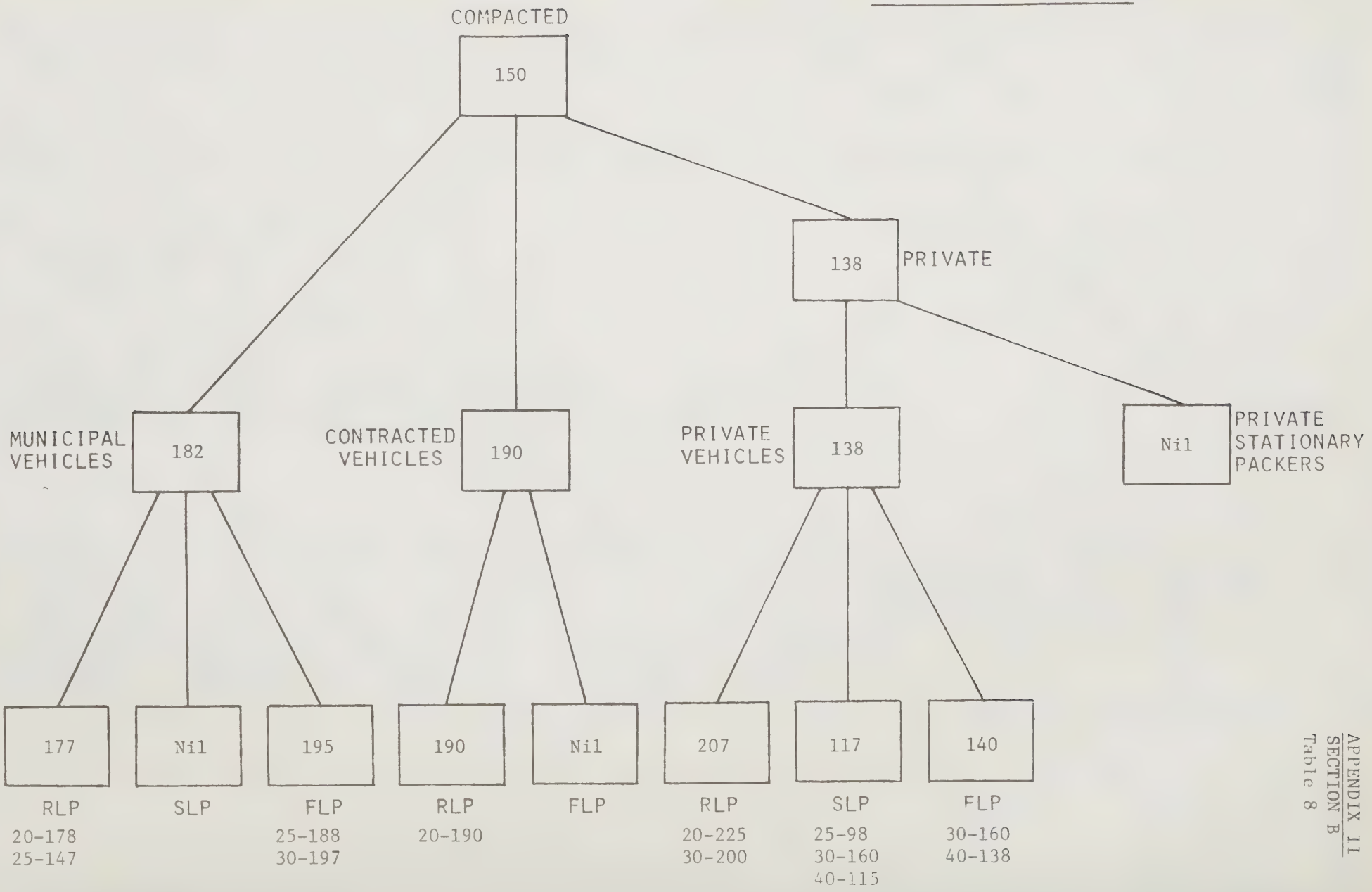
5 SITES



APPENDIX II
SECTION B
Table

COLLECTION WASTE DENSITY-SAMPLING RESULTS

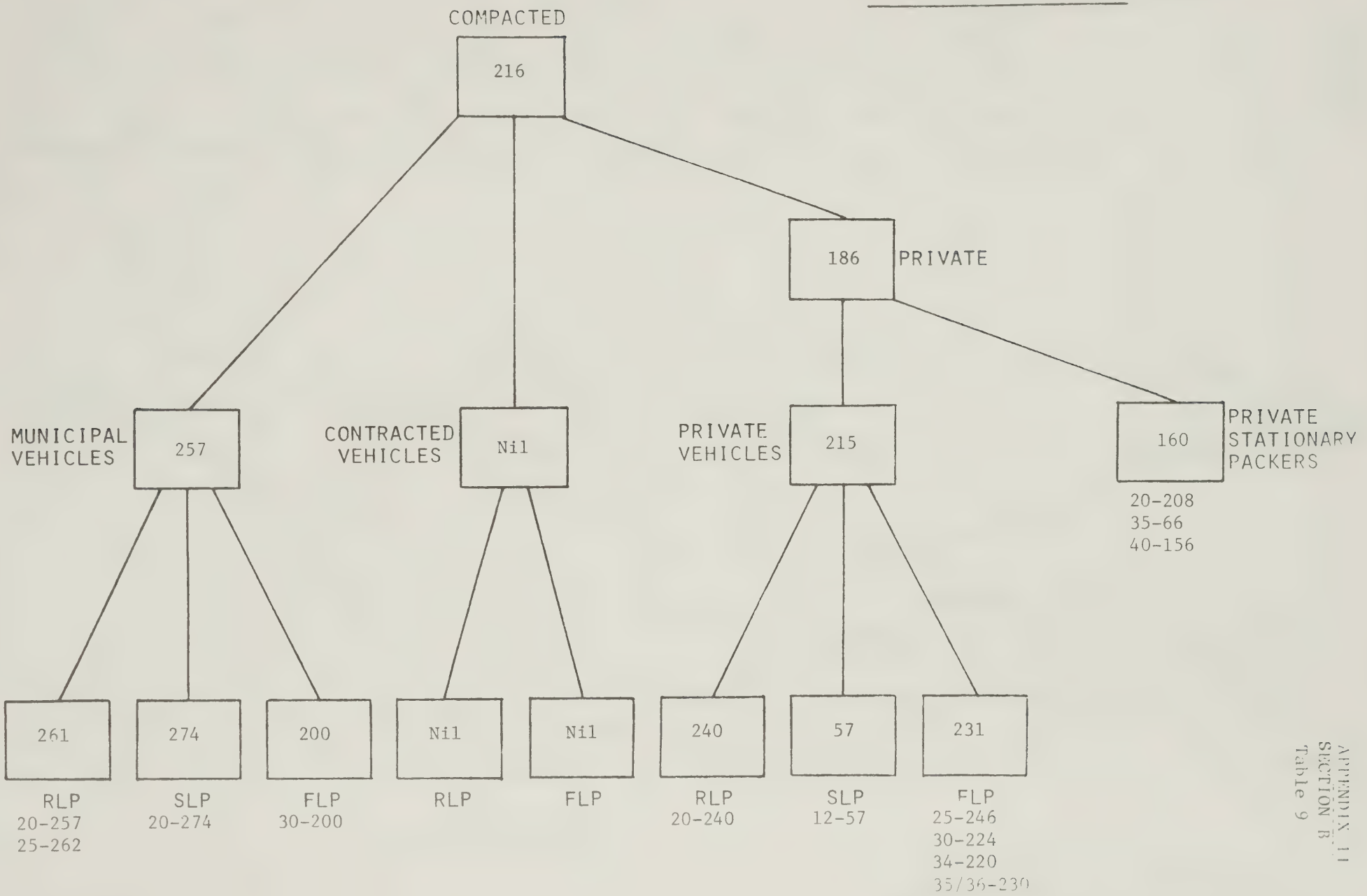
Beare Road SITE



APPENDIX II
SECTION B
Table 8

COLLECTION WASTE DENSITY-SAMPLING RESULTS

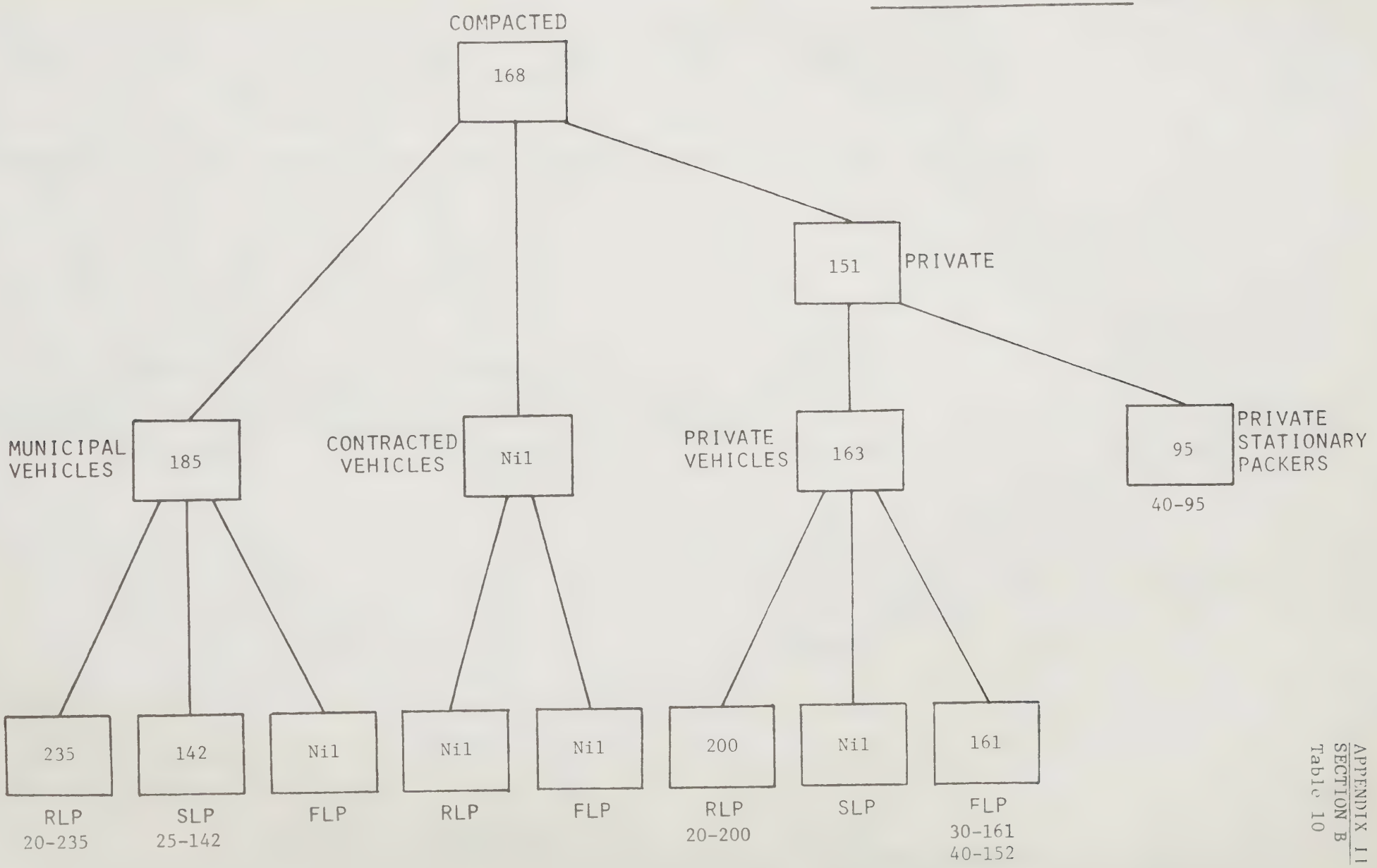
London SITE



APPENDIX 11
SECTION B
Table 9

COLLECTION WASTE DENSITY-SAMPLING RESULTS

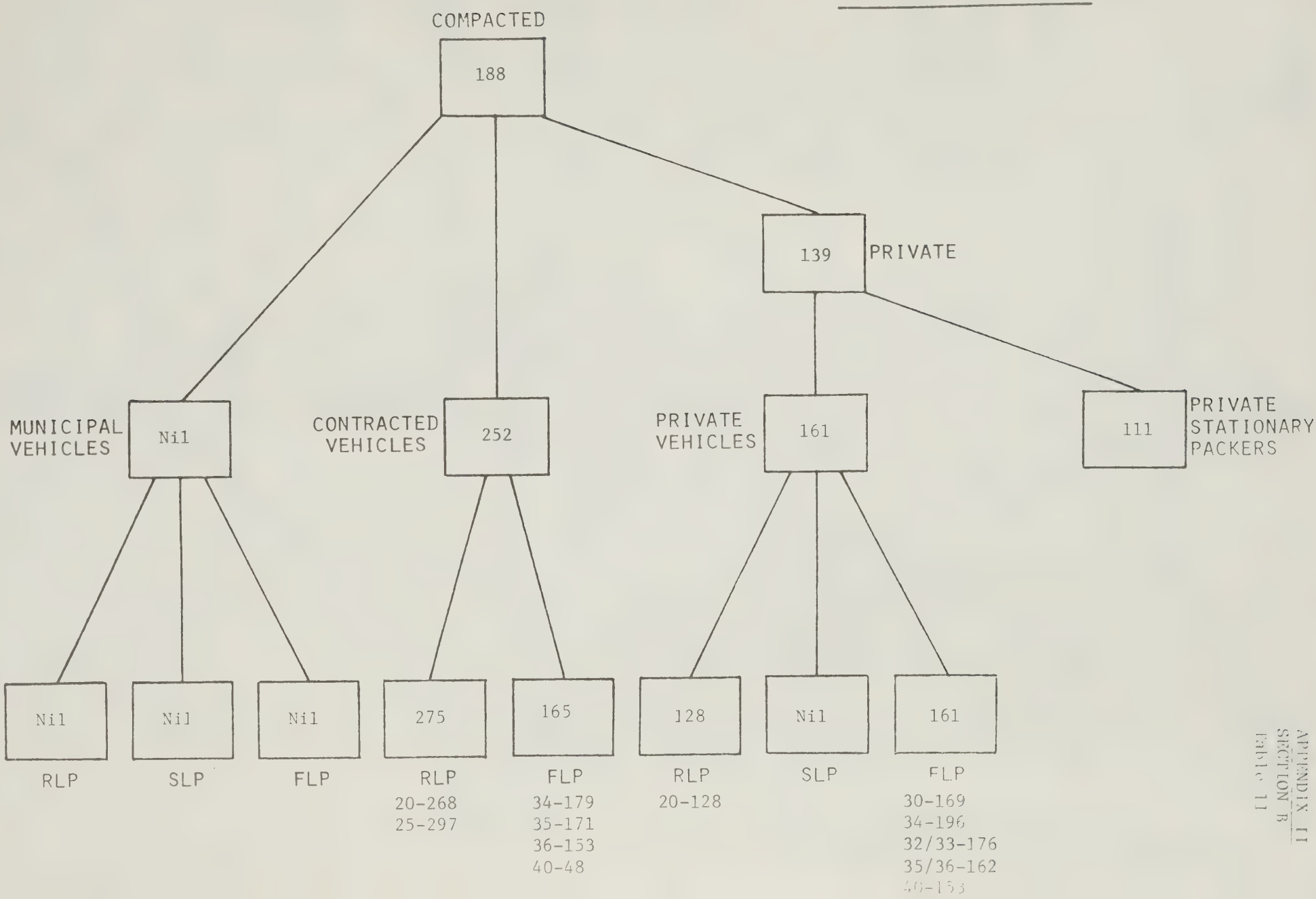
Brock West SITE



APPENDIX II
SECTION B
Table 10

COLLECTION WASTE DENSITY-SAMPLING RESULTS

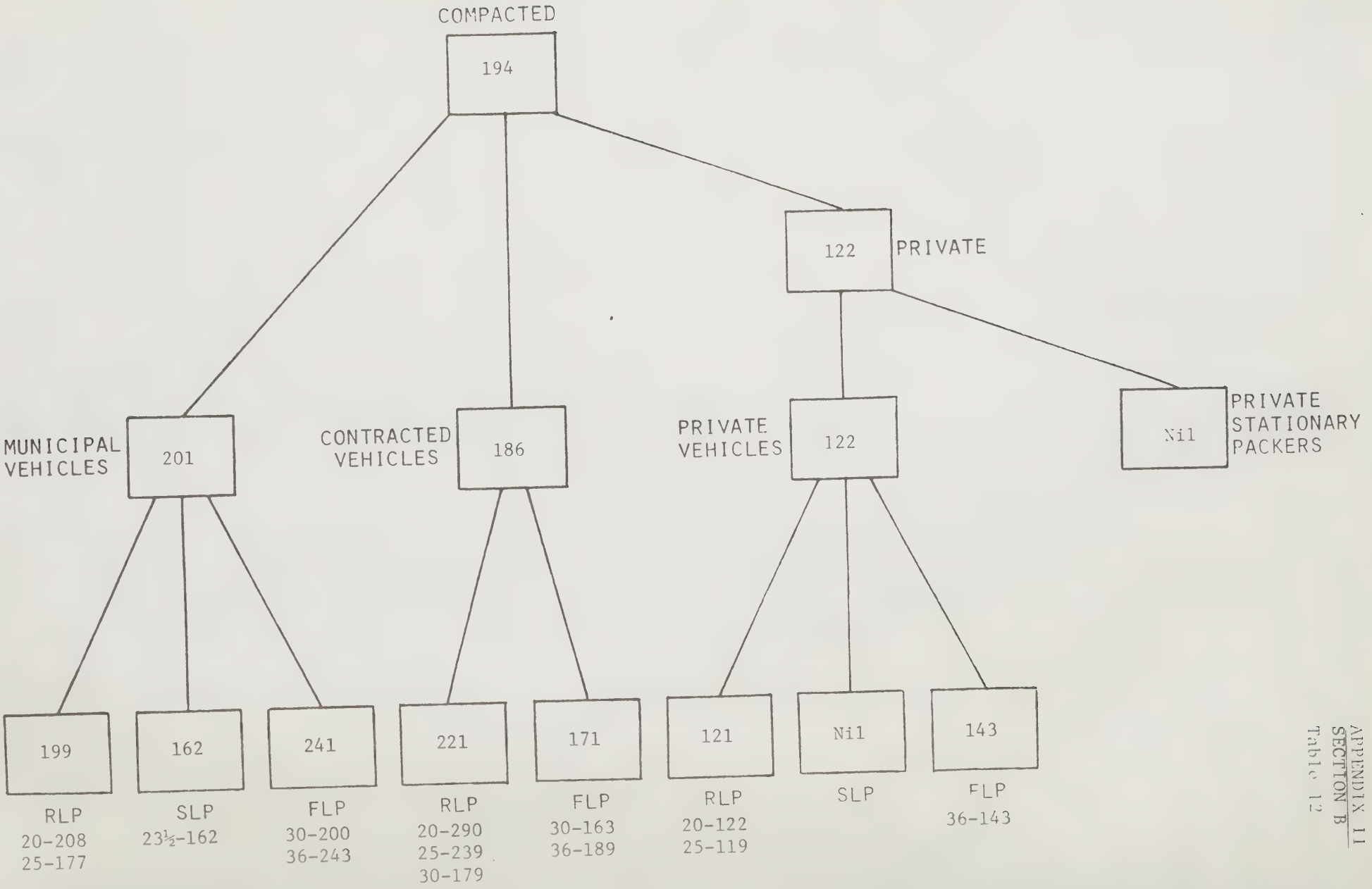
Erin Mills SITE



APPENDIX II
SECTION B
Table 11

COLLECTION WASTE DENSITY-SAMPLING RESULTS

Ingram Dr. SITE



APPENDIX II
SECTION B
Table 12

MISCELLANEOUS TRUCK DENSITY FACTORS

(February 1979)

OPERATOR	VEHICLE TYPE	WEIGHT PER LOAD KG.	
Municipal	Stake and Dump Trucks	2,239	
Contracted for Municipality	Dump Trucks	10,865	
Private	Stake Trucks	1 ton 624 2 ton 1,379 3 ton 1,158 4 ton 600 5 ton 2,266 6 ton 1,230 7 ton 377 8 ton 1,817 10 ton 970 1,158 (average)	Larger Sample Required
Private	Single Axle Trucks Dual Axle Trucks	2,002 4,201	
Homeowners	Misc. cars, vans, pickup	408	
Municipal	Transfer Vehicles 75 yard tractor trailers	17,875	
Contractors	Transfer Vehicles 53 yard to 66 yards	18,504	

"A.M." AND "P.M." DENSITY FACTORS

During our analysis of the truck weight sample data, it became evident that the municipal "p.m." loads were normally lighter than the "a.m." loads. Thus, a separate analysis was prepared as shown on Table 1, following. The key results of the analysis are as follows:

- The average "p.m." weight was lighter than the "a.m." weight in seven of the eight municipalities sampled.

- "p.m." loads were heavier in four cases of the fifteen vehicle catagories. The vehicles that were heavier were thirty cubic yard front loading packers in three of four cases. A possible reason for this occurrance may be due to these vehicles being used for commercial or apartment routes where more rigid service levels may apply.

- On average, the "p.m." loads were 20% lighter than the "a.m." loads.

We conclude from our analysis that there is generally a lower performance expectation from municipal crews on the afternoon collection. We were unable to verify whether the variance in loads is due to a lower expectation to allow for contingencies should there be problems on the morning route, or whether the crews themselves attempt to schedule the pickups to enable early job completion. We consider the differences in "p.m." density significant and thus recommend that the reasons for variances be investigated by municipal staff.

"A.M." VERSUS "P.M." DENSITIES

Municipality	Vehicle Type	Vehicle Size in Cubic Yards	# of Loads	Density KG, per Cubic Yard A.M.	Density KG, per Cubic Yard P.M.	P.M. % of A.M.
York	Rear Loading Packer	20	23	185	138	75%
North York	Rear Loading Packer	25	38	222	138	62%
Toronto	Rear Loading Packer	20	2	233	253	108%
Etobicoke	Rear Loading Packer	20	29	261	221	85%
	Front Loading Packer	36	4	246	251	102%
	Side Loading Packer	23½	3	180	118	65%
	Average					85%
London	Rear Loading Packer	20	6	290	242	83%
	Rear Loading Packer	25	42	288	238	83%
	Front Loading Packer	30	1	192	198	103%
	Side Loading Packer	20	1	296	251	85%
	Average					83%
Scarborough	Rear Loading Packer	20	32	263	130	49%
	Rear Loading Packer	25	1	218	76	35%
	Front Loading Packer	30	7	202	204	101%
	Average					59%
Ajax	Side Loading Packer	25	11	176	148	84%
Pickering	Rear Loading Packer	20	11	259	198	76%
			TOTAL	3511	2804	80%

APPENDIX 11
SECTION C
TABLE 1

SEASONAL WASTE GENERATION STATISTICS AND ANNUALIZATION FACTORS

In previous sections of the appendices, we described the need for density factors for solid waste so that non-weighing municipalities can estimate annual tonnage. One key factor in this estimating process is the month during which the truck count is taken, since waste generation fluctuates substantially during the year. To allow for this variation, seasonal waste generation statistics were reviewed as follows:

- Waste generation figures for Metropolitan Toronto were obtained for 1975 to 1978. These are plotted on Tables 1 to 3, following.

- Waste generation figures for the Region of Peel were also reviewed and shown to have similar monthly trends as shown on Table 4, following.

From our review, it was clear that April/May/June and August/September/October were higher months for waste generation. Since four years figures were available for Metropolitan Toronto, these statistics should be used by non-weighing municipalities for forecast annual tonnage, unless more accurate local data is available.

While reviewing the absolute increase in tonnage in different months, it was recognized that this increase could arise from two factors:

- An increase in the number of loads being disposed of, and
- an increase in the density per load.

To segregate these two causes of tonnage variation, additional truck weight samples were taken at two Metropolitan Toronto landfill sites in May, 1979. A comparative summary of the results from the Brock West site are shown on Table 5, following. Highlights from the summary are as follows:

- Residential waste landfilled in the May sample increased by +152% over the February sample level.

- Private waste increased in each of the broad categories, as follows:

  - Municipal compacted waste +33% per cubic yard.
  - Municipal loose waste +730% per load.
  - Private compacted waste +7% per cubic yard.
  - Private loose waste +32% per cubic yard.

From the Beare Road landfill site sample (see Table 6 for details) the following key highlights were evident:

- Municipal compacted waste increased by 51% in a week in May over a week in February, whereas municipal loose waste declined by 74%. The total municipal variation was +1%.

- Contractors waste increased by 243% in May over the February level.

- Private waste increased in total by 79% while one element, compacted, declined by 25%.

- The total waste weight increase was 66% versus the 78% increase recorded at the Brock West site.

- The density increases recorded were as follows:

  - Municipal, compacted +35%
  - Municipal, loose - 53% (per load)
  - Contractor, compacted +107%
  - Private, compacted +21%
  - Private, loose +42%
  - Private, miscellaneous +30% (per load)

- Since the density change for contractors (107%) could not be verified for reasonableness with the Brock West sample, this data was disregarded. It is suggested that the municipal compacted change percentage will be a more reasonable basis for density change until further seasonal verification can be made.

- The variation in densities per load were also ignored since there was no clear correlation of the figures to the February density samples.

Since our May sample from Beare Road contained a much larger tonnage and number of vehicles than Brock West, we decided to use these figures to calculate seasonal density adjustement percentages.

We applied the proportion of "density increase" to the overall seasonal waste factors derived in Table 3 (Metropolitan Toronto, four years statistics) and arrived at density adjustment percentages. These are displayed on Table 4 in the report, following page 34.

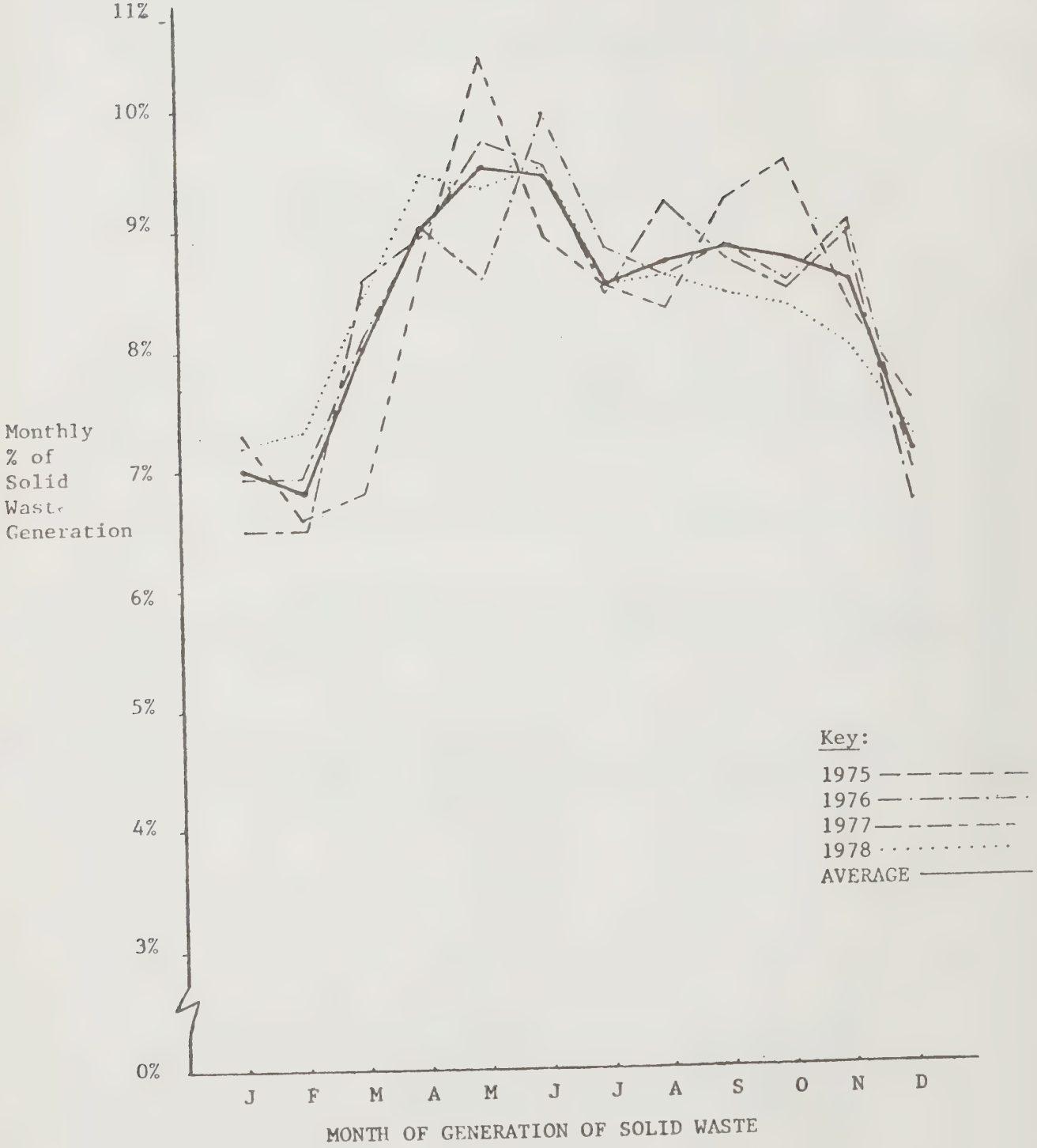
SEASONAL GENERATION OF SOLID WASTE - % PER MONTH
(RESIDENTIAL, COMMERCIAL AND INDUSTRIAL)

METROPOLITAN TORONTO

Month in Year	1975	1976	1977	1978	Metro Average
January	7.3	6.9	6.5	7.2	7.0
February	6.6	6.9	6.5	7.3	6.8
March	6.8	8.1	8.6	8.4	8.0
April	8.7	9.0	8.9	9.4	9.0
May	10.4	8.6	9.7	9.3	9.5
June	8.9	9.9	9.5	9.5	9.4
July	8.5	8.8	8.4	8.5	8.5
August	8.3	8.6	9.2	8.6	8.7
September	9.2	8.8	8.7	8.4	8.8
October	9.5	8.5	8.4	8.3	8.7
November	8.3	9.0	8.9	7.9	8.5
December	7.5	6.9	6.7	7.2	7.1
	100.0	100.0	100.0	100.0	100.0

METROPOLITAN TORONTO SOLID WASTE GENERATION, 1975 - 1978

- SEASONAL FACTORS -



SEASONAL GENERATION OF SOLID WASTE
MONTHLY AND WEEKLY FACTORS

Month	Monthly % Generated*	Days in Month	Weekly % Generated
January	7.0	31	1.58
February	6.8	28	1.70
March	8.0	31	1.81
April	9.0	30	2.10
May	9.5	31	2.06
June	9.4	30	2.19
July	8.5	31	1.92
August	8.7	31	1.96
September	8.8	30	2.05
October	8.7	31	1.96
November	8.5	30	1.98
December	7.1	31	1.60
	100.0%	365	

* Derived from analysis of 4 years of Metropolitan Toronto data (1975-1978)

SEASONAL GENERATION OF SOLID WASTE TONS & % PER MONTH
(RESIDENTIAL, COMMERCIAL & INDUSTRIAL)

- REGION OF PEEL -

Month (1978)	Mississauga		Chinguacousy*	Albion*	Caledon*	Peel Region	%
January	14,599		10,557	487	436	26,079	7.1
February	13,497	6.2	10,633	494	434	25,058	6.8
March	16,899		11,190	509	433	29,031	7.9
April	18,873		11,872	485	478	31,708	8.6
May	21,970		13,320	649	507	36,446	9.8
June	20,505		13,011	669	501	34,686	9.4
July	16,837		10,348	599	499	28,283	7.7
August	18,299		11,985	818	534	31,636	8.6
September	19,258		11,111	715	518	31,602	8.6
October	19,946		11,718	738	469	32,871	8.9
November	20,057		12,195	579	477	33,308	9.0
December	17,167		10,004	386	521	28,078	7.6
Total	217,907		137,944	7,128	5,807	368,786	100.0%

*Tonnage based on Truck count and weight estimates.

APPENDIX 11
SECTION D
TABLE 4

SEASONAL SOLID WASTE VARIATION

COMPARISON OF FEBRUARY AND MAY 1979
LOADS COUNTS, WEIGHTS AND DENSITY FACTORS

BROCK WEST LANDFILL SITE

Operator/Type of Waste	February 1979 Weight Kg	February 1979 # Loads	February 1979 Density Kg per yd^3	May 1979 Weight Kg	May 1979 # Loads	May 1979 Density Kg per yd^3	Variation % Total Weight Kg	Variation % # Loads	Variation % Density Kg per yd^3	Adjust. To Metro Level (27.2%)
Municipal										
Compacted	223,690	54	185	506,980	93	246	+127%	+ 72.2%	+ 33.0%	9.0%
Loose (per load)	1,640	5	328 Ld.	59,920	22	2,724 Ld.	-	+340%	+730%	N/A
Total	225,330	59		566,900	115		+152%	+ 95%		
Private										
Compacted	209,700	48	132	320,530	57	141	+ 53%	+ 19%	+ 7%	1.9%
Loose	183,860	86	68	214,590	78	90	+ 16%	- 9%	+ 32%	8.7%
Total	393,560	134	91	535,120	135	115	+ 36%	+ 1%	+ 26%	
Grand Total	618,890	193		1,102,020	250		+ 78%	+ 32%		
Municipal % of Total Weight	36%			51%						

- Metropolitan Toronto, total weight Change Percentage (May vs. February level) + 21.2%
- Metropolitan Toronto weight change % as a proportion of Brock West 27.2%

APPENDIX II
SECTION C
TABLE 5

COMPARISON OF FEBRUARY AND MAY 1979
LOADS COUNTS, WEIGHTS AND DENSITY FACTORS

BEARE ROAD LANDFILL SITE

Operator/Type of Waste	February			May			Variation %			Adjust. To Metro Level (32.1%)
	Weight Kg	# Loads	Density Kg per yd^3	Weight Kg	# Loads	Density Kg per yd^3	Total Weight Kg	# Loads	Density Kg per yd^3	
Municipal										
Compacted	345,010	78	173	521,180	106	234	+ 51%	+ 36%	+ 35%	11.2%
Loose (per load)	229,100	21	10,912	60,970	12	5,081	- 74%	- 43%	- 53%	N/A
Total	574,110	99		582,150	118		+ 1%	+ 19%		
Contractors to Municipality										
Compacted	12,530	6	104	43,040	10	215	+243%	+ 67%	+107%	34.3%
Private										
Compacted	1,086,740	212	137	816,640	143	166	- 25%	- 33%	+ 21%	6.7%
Loose	1,073,770	331	105	2,673,980	495	149	+149%	+ 50%	+ 42%	13.5%
Misc. Loads	439,680	225	1,954	1,159,320	457	2,537	+163%	+103%	+ 30%	9.6%
Total	2,600,190	768		4,649,940	1,095		+ 79%	+ 43%		
Grand Total	3,186,830	873		5,275,130	1,223		+ 66%	+ 40%		
Municipal % of Total Weight	18%			12%						
Metropolitan Toronto Total Weight Change % (May vs February level)							+ 21.2%			
Metropolitan Toronto Weight as a Proportion of Beare Road							32.1%			
										32.1%

APPENDIX II
SECTION D
TABLE 6

TESTING OF DENSITY FACTORS AND ANNUALIZATION FACTORS

Analyses were carried out to test the density factors and annualization factors. One week sample truck count data for February 1979 was taken from two landfill sites and province-wide density factors and annualization factors were applied (see Tables 1 and 2 following).

The total tonnages extrapolated for 1979 were then compared to the reported 1978 tonnages and were within 10%. Predominant vehicle weight densities (actual custom density factors) were substituted for the province-wide density factors and the estimated tonnages for 1979 were still within 10% of the 1978 total weights.

From this test, it is reasonable for non-weighing municipalities to use the province-wide density factors and annualization factors to extrapolate annual tonnage.

To test the applicability of the seasonal density adjustment percentages and the annualization factors, tests were carried out using truck count data from two municipalities' landfill sites.

The seasonal factors were used first for data from suburban regions landfill sites. Table 3 following shows details of the comparisons made where the estimated annual tonnage differs marginally using truck count from two different months.

When the seasonal factors were applied to truck count data from a landfill site in a southeastern city (see Table 4), the results were not useful. Using an April base the annual tons were estimated at 38,878, and using a September base, the annual tons were estimated at 28,807, for a difference of 23%. Since this landfill site is used mainly by private industry and a less expensive alternate privately operated site is available, this may have adversely impacted the basic truck count data.

We concluded from these tests that when a landfull site is used regularly by the same disposers, truck counts and the seasonal factors can be used to estimate annual tonnage within a reasonable accuracy range. When the composition and consistency of users is flexible, the seasonal factors cannot be expected to eliminate inherent differences in actual truck counts.

COMPARISON OF USE OF PROVINCE WIDE DENSITY FACTORS AND SEASONAL FACTORS
TO ACTUAL ANNUAL WEIGHTS, AT
SUBURBAN REGIONAL NORTH SHERIDAN WAY LANDFILL SITE

Operator	Vehicle Type	Capacity	# of Loads	# of Yards	Provincial Density Factor kg	Total Weight Estimate kg	Difference If Custom Density Factors Are Applied: Density Factor kg	Difference If Custom Density Factors Are Applied: Total Weight Estimate
Contractor	RLP	20	138	2,760	249	687,240	+ 19	+ 52,440
		25	38	950	297	282,150	+ 0	---
	FLP	34	26	884	171	151,164	+ 8	+ 7,072
		35	5	175	171	29,925		
		36	8	288	171	49,248		
		40	1	40	171	6,840		
	RD	30	21	630	102	64,260		
		40	13	520	80	41,600		
Private	RLP	20	2	40	190	7,600		
	FLP	30	28	840	179	150,360	- 10	- 8,400
		34	1	34	208	7,072		
		32½	8	260	176	45,760		
		35½	30	1,065	179	190,635	- 17	- 18,105
		40	37	1,480	148	219,040	+ 5	+ 7,400
	SP	20	5	100	195	19,500		
		30	6	180	131	23,580		
		40	59	2,360	121	285,560	- 12	- 28,320
		50	4	200	87	17,400		
	LB	14	28	392	120	47,040		
		20	2	40	126	5,040		
		22	1	22	136	2,992		
	RD	14	63	882	165	145,530	- 36	- 31,752
		20	54	1,080	139	150,120	+109	+ 117,720
		25	6	150	94	14,100		
		30	6	180	84	15,120		
		40	162	6,480	66	427,680	+ 5	+ 32,400
Principal	Misc.Dump	--	37	37(L)	2,239	82,843		
Private	SA	--	52	52(L)	2,002	104,104		
	DA	--	34	34(L)	4,201	142,834	+ 0	
Homeowners etc.	--	--	63	63(L)	408	25,704		
						3,442,041	New Total	3,572,497
						3,442 Tonnes		3,572 Tonnes
Calculation of Annual Weight		3,442 X $\frac{100}{1.7}$	= 202,471 Tonnes					210,118 Tonnes
Estimated 1979			= 223,183 Tons (+2.4%)					231,613 Tons (+6.3%)
Reported by the Municipality 1978			= 217,917 Tons					217,917 Tons

APPENDIX 11
SECTION E
Table 1

COMPARISON OF USE OF PROVINCE WIDE DENSITY FACTORS AND SEASONAL FACTORS, TO ACTUAL ANNUAL WEIGHTS AT WESTMINISTER LANDFILL SITE AT SOUTHWESTERN CITY

Operator	Capacity	# of Loads	# of Yards	Provincial Density Factor kg	Total Weight Estimate kg	Difference If Custom Density Factors Are Applied	
						Density Factor Difference	Weighted Estimate Difference
Municipal	20	14	280	217	60,760		
	25	90	2,250	195	438,750	+ 67	+ 150,750
	20	2	40	274	10,960		
	30	6	180	199	35,820		
Contract	30	4	120	102	12,240		
	35	2	70	72	5,040		
	40	2	80	80	6,400		
Private	20	7	140	190	26,600		
	12	14	168	57	9,576		
	25	8	200	246	49,200		
	30	15	450	179	80,550	+ 45	+ 20,250
	34	11	374	208	77,792	+ 12	+ 4,486
	35/36	12	426	179	76,254	+ 51	+ 21,726
	20	4	80	195	15,600		
	35	1	35	66	2,310		
	40	46	1,840	121	222,640	+ 35	+ 64,400
	10	7	70	455	31,850		
	12	31	372	231	85,932	+ 8	+ 2,976
	20	29	580	126	73,080	+ 93	+ 53,940
	14	2	28	165	4,620		
	20	29	580	139	80,620	+ 80	+ 46,400
	25	3	75	94	7,050		
	30	21	630	84	52,920		
	40	31	1,240	66	81,840	- 8	- 9,920
	35	16	560	65	36,400		
Municipal	--		12 (Lds)	2,239	26,868		
Contracto	--		29 (Lds)	10,865	315,085	Ø	Ø
Private S	--		150 (Lds)	1,158	173,700	+ 436	+ 65,400
Private D	--		14 (Lds)	2,485	34,790		
Private	--		1 (Ld)	7,350	7,350		
					2,142,597 kg	New Total	2,563,005
					2,143 Tonnes		2,563 Tonnes
Estimated	2,143 X $\frac{100}{1.7}$	=	126,059 Tonnes				150,765 Tonnes
Estimated		=	138,955 Tons (-10%)				166,188 Tons (+7.6%)
Reported	1978	=	154,444 Tons				154,444 Tons

APPENDIX II
SECTION E
Table 2

APPLICATION OF SEASONAL FACTORS

ADJUSTED SEASONAL DENSITY FACTORS

REGIONAL LANDFILL SITE

Category of Waste	February 1978 Total Weight Estimate KG	Seasonal Density Adj. Factor	Adjusted Total Weight KG	May 1978 Total Weight Estimate KG	Seasonal Density Adj. Factor	Adjusted Total Weight KG
Contract Collected Residential Compacted	2,856,010	Ø	2,856,010	4,692,413	+11.2%	5,217,963
Residential Loose & Misc. Loads	238,965	Ø	238,965	311,278	Ø	311,278
Private Compacted	3,142,739	Ø	3,142,739	3,471,472	+ 6.7%	3,704,061
Private Loose	4,110,198	Ø	4,110,198	5,040,376	+13.5%	5,720,827
Total KG	10,347,912	Ø	10,347,912	13,515,539		14,954,129
Tonnes			10,348			14,954
Monthly % of (Seasonal Waste Factors) Total Weight			6.8%			9.5%
Estimated Annual Tonnage			152,176			157,411
						+3.4%

APPENDIX II
SECTION I
Table 3

APPLICATION OF SEASONAL FACTORS

(ADJUSTMENT OF DENSITY FACTORS)

SOUTH EASTERN CITY LANDFILL SITE

Categories	April 1978 Total Weight KG	April 1978 Density Adj.Factors	April 1978 Adjusted Total Weight KG	September 1978 Total Weight KG	September 1978 Density Adj.Factors	September 1978 Adjusted Total Weight KG
Private Compacted	1,848,410	+ 2.1%	1,887,227	1,489,320	+ 6.5%	1,586,126
Private Loose	1,259,368	+ 9.7%	1,381,527	764,992	+13.1%	865,206
Misc. Half tons & Cars	230,652	Ø	230,652	189,243	Ø	189,243
	3,338,430		3,499,406	2,443,555		2,640,575
Tonnes			3,499			2,641
Monthly % of Total Waste			9.0%			8.8%
Annual Weight Estimated Tonnes			38,878			30,011
						23% Difference

APPENDIX II
SECTION E
TABLE 4

STATISTICAL ANALYSIS OF TRUCK DENSITY FACTORS AND PREDICTABILITY

The purpose of our statistical analysis of truck density factors was to obtain average values of waste density from locations having weighing capability and use this information to predict waste densities at non-weighing locations. Our approach to the statistical analysis was as follows:

- Sample weights were obtained at each of the six locations visited during the winter months. In all, 3,377 samples were taken excluding miscellaneous truck types. The data represented a meaningful sample size of the various truck types and class of operator for compacted and loose waste.

- Subsequently, the data was arranged in a fashion that would provide the most meaningful results to Waste Management personnel. Data was organized as follows:

  - By operator (e.g., municipal versus private)
  - By loose or compacted waste.
  - By vehicle type and size.

This arrangement of data is illustrated by the various organization charts included in Section B of this Appendix. After the analysis, it was observed that within each of the various categories of data arrangements, there was a large variation among the individual measurements obtained. Accordingly, we decided to use average values obtained at each location to reduce the effects of the variation on the overall results. This meant that once this work had been completed, there would be no more than one average value for each waste classification at each site, or there would be no more than six average values for each classification when all the sites were included. In a few cases, there were only one or two average values available to represent a particular classification.

A measure of the accuracy of these results was required. Accordingly, we undertook statistical analysis procedures to obtain this information. The distribution of the data was assumed to be normal and we applied the principles of statistical inference and the "student-t" distribution function. This work resulted in defining the probable bound on the error by using the mean of the data for the various locations at a 95% confidence interval. The bound on the error was referred to as the upper and lower limits of accuracy.

To provide additional information regarding the behaviour at individual locations we undertook and completed a comprehensive statistical evaluation of all the data for the Scarborough vehicles.

Certain other considerations were not dealt with at this preliminary level of analysis. These consideration include: -

- the effect of variations in the ambient moisture level of the atmosphere during different seasons and at different geographic locations,

- certain characteristic differences in the waste density profile due to demographics, and

- the effective utilization of available truck space.

Waste Management personnel may wish to consider some of these influencing factors in subsequent studies.

The results of our analysis are that mean values have been obtained for twenty-one different arrangements of truck type, and operator, and a further twenty-six means for the various sizes of trucks involved. However, the bound on the error of a majority of these mean values is quite large; in excess of ±50% of the value of the mean (see Table 3 in the main body of the report for detail). This was visually apparent without undertaking formal statistical analysis procedures. However, the results of these procedures confirmed observations.

Results obtained from a comprehensive analysis of the Scarborough vehicles confirm that there was a very large variability in the weight of waste carried by each truck type and that weights (and therefore densities) are significantly larger in the morning than in the afternoon. This has been observed at each of the other six locations although not statistically verified. (Further details of "a.m." and "p.m." weights is included in Section C of this Appendix).

Our conclusions from the statistical analysis are as follows:

- Although a valuable way of organizing and classifying the various types of waste carrier has been provided, efforts to accurately predict weight and density figures at non-weighing locations have not been successful.

- To reduce the large possible error associated with using the mean value obtained, greater sample detail will be required. This detail should consist of:

  - more sites sampled, and
  - consideration of demographics.

- There may be certain interdependencies between demographic factors and geographical location. This should also be considered.

- The predictability of density factors for specific municipal vehicles is more accurate if separate factors for morning and afternoon loads are used, as follows;

Scarborough - 20 Cubic Yard Rear Loading Packer

	Upper Limit	Mean	Lower Limit	% Spread
A.M. Load	5,439	5,253	5,067	± 2.5%
P.M. Load	2,980	2,602	2,224	±14.5%

Since the statistical analysis did not verify the predictability of the density factors, we concluded that sample weighing of predominant truck types in non-weighing municipalities will be necessary. In this way, these municipalities will then be able to substitute custom density factors for the province-wide density factors, and improve the accuracy of predictions.

APPENDIX III

MUNICIPAL INPUT

TABLE OF CONTENTS

Section	
A	REVISED MUNICIPAL INPUT FORMS AND INSTRUCTIONS - FOR LARGER MUNICIPALITIES (MORE THAN 10,000 POPULATION) - FOR SMALL MUNICIPALITIES
B	CAPITAL COST CALCULATIONS - COLLECTION EQUIPMENT - LANDFILL SITES
C	METROPOLITAN TORONTO, EXAMPLES OF WORKSHEETS AND BASIC INSTRUCTIONS
D	OVERHEAD ALLOCATIONS - REVIEW OF MUNICIPAL INPUT
E	SEGREGATION OF HAUL COSTS FROM ROUTE COLLECTION COSTS

ENHANCEMENTS TO THE MUNICIPAL INPUT FORMS

During the pilot implementation project, meetings were held with municipal staff to review the input forms and the information required. At those and subsequent meetings, the ease of completion of the forms was reviewed. In summary, the comments made by municipal staff and our observations concerning the input forms are as follows:

- Presenting the information requirements on nineteen pages (e.g. collection) can cause the following problems:
  - The task of completing the forms may appear onerous.
  - Staff cannot easily review all of the information required at one glance to aid their understanding of the data needed.
  - The interrelationship of the different pieces of information cannot be determined easily.
- Including instructions for completion of the forms within the forms themselves was found confusing, e.g., in one municipality the individual involved completed several of the forms, only to find that on the next page there were more instructions on data completion.
- Requesting absolute detail regarding every collection route and each vehicle was felt to be an onerous task.
- Staff at the small rural municipality felt that too much detail was required for their scope of operations.
- Differentiation was not made between the key information required for completion of the provincial report, and the less significant data that was "desirable" input for analysis purposes.
- There were no example figures shown in the forms that could help municipal staff gain a better understanding of data requirements.

As a result of the above comments and our observations during the pilot implementation, the municipal input forms were restructured and condensed. Key objectives in revising the format were as follows:

- Reduce the quantity of forms involved so that the task of completing the returns is less onerous.
- Segregate the instructions from the actual forms so that example figures could be included.

Ontario

Ministry
of the
Environment

WASTE
MANAGEMENT
BRANCH

SOLID WASTE MANAGEMENT
COSTING SYSTEM

MUNICIPAL INPUT 19__
FOR COLLECTION ACTIVITY

MUNICIPALITIES OF OVER 10,000 POPULATION

Description of Municipality

Code
(For.)
(Office)
(Use)

Municipality _____

Description (Region, City, Town, etc.) _____

Mailing Address _____

Postal Code _____ Telephone # ( )- _____

Municipal Contacts

Name	A. _____	B. _____
Title or Position	B. _____	B. _____

1. Demographic Data

Enumerated Fall Population _____

Number of Households:

- Municipally Collected _____
- Contract Collected _____
- Not Served _____

Total # of Households _____

2. Tonnage Data

Number of Tons:	W	E
• Municipally Collected _____	☐	☐
• Contract Collected _____	☐	☐

Total # of Tons _____
(w = weighed, e = estimated)

3. Cost and Financial Information

Municipal Costs	$
• Direct Labor	
• Equipment Reps & Maint.	
• Equipment other optg.	
• Overhead Direct	
• Overhead Allocated	
• Capital Costs	
•	
Total Costs	
• Revenues	
Net Cost (A)	

Contract Costs	$
• Contract Direct Charges	
• Municipal Overhead Allocated	
•	
Total Contract Costs (B)	

Total

- Municipal Collection (A) _____
- Contract Collection (B) _____

Total Net Cost of Collection _____

4. Fleet Description

Vehicle Description		Municipal				Contract			
		# of Units		Fuel	Crew			Fuel	Crew
Type	Size Yds.	Active	Spare	Type	Size	Active	Spare	Type	Size

Annual Truck Volume
Collected Cubic Yards — Municipal _____ Contract _____

Annual Fuel Usage Gas _____ Diesel _____

5. Labour Productivity

	Municipal	Contract
Hours worked on 'Beat'		
Hours on Haul		
Hours not worked		
Total Hours Paid		
Overtime Hours Included Above		

MUNICIPAL INPUT 19 , COLLECTION DATA, KEY INFORMATIN (CON'T)

6. ROUTE DESCRIPTIONS

Type of Route	Municipal # of Routes	Municipal Freq. of Coll'n	Municipal Point of Pickup	Municipal 1 or 2 Side Col	Contract # of Routes	Contract Freq. of Coll'n	Contract Point of Pickup	Contract 1 or 2 Side Col
Residential								
Apartment								
Commercial								
Res./Apt.								
Res/Apt/Comm.								
Other _____								
Total/ Predominant								

Numeric Data	Municipal High	Municipal Average	Municipal Low	Contract High	Contract Average	Contract Low
Number of Pick-up Points						
Number of Households						
Call Route Miles						
Haul Distance to Disposal						
# of Loads per day						

7 OTHER OPERATING AND PHYSICAL DATA (IF AVAILABLE)

- Seasonal Variation in Population (± 10%): When _____ ± _____ %
- Type of collection used predominantly:

	Municipal	Contract
Residential - Bag or Can	_____	_____
- Bulk	_____	_____
- Special Clean-up	_____	_____
- Other ( )	_____	_____
Special Collections carried out	_____	_____

Type of Material _____

- Municipal Vehicle Rental Rate (Predominant) $ _____
- Vehicla Rental Basic Hour ☐ Day ☐ Week ☐ Minimum Charge ☐
- Are collection vehicles used for other purposes: Comment _____

_____

8. OTHER MUNICIPAL CREW DATA

- Collection crew employment system

Hours Per Week Paid _____

Days Per Week Worked _____

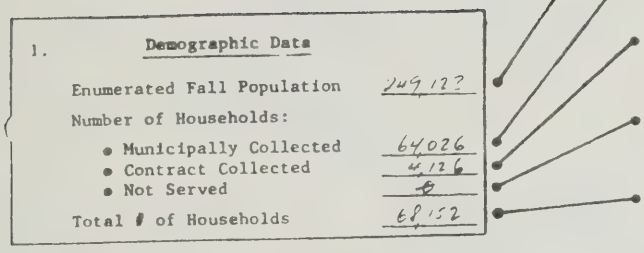
- Fixed Hours No Overtime ☐
- Fixed Hours Overtime Paid ☐
- Task incentive, Route Completion ☐
- Task incentive, All Routes Complete ☐
- Other _____

- Number of Crews ____, Number of Foremen _____
- Hourly rates; Driver $_____, Collection $_____, Other ( ) $ _____

INPUT COMPLETION INSTRUCTIONS

MUNICIPAL INPUT 19 , COLLECTION DATA, KEY INFORMATION

(COLLECTION DATA)



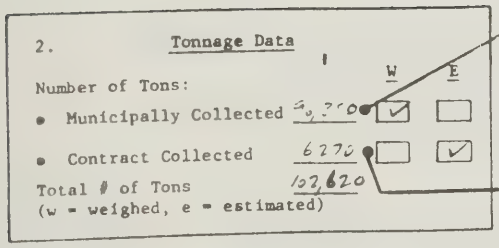
Population per the Annual Municipal Financial report/Enumeration Roll

Per the residential taxation records for solid waste collection

Per the contract agreement for Collection

Households not served municipally or by contract

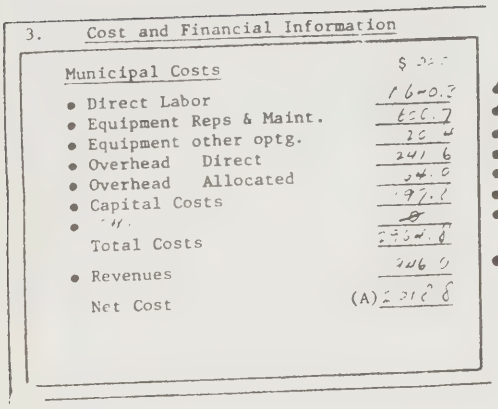
Total number of households per enumeration records, also shown on municipal financial report



Tonnages extracted from the local landfill sites records

Estimate provided by contractor since in this example he does not use a site with scales

INPUT COMPLETION INSTRUCTIONS
(COLLECTION COSTS)



Direct Labor and benefits costs for collection crews full time, part time, overtime and any other wage related allowances

Repair and maintenance labour costs, benefits, parts costs and outside repairs

Includes oil, fuel, licenses, insurance, etc. ie any non-maintenance vehicle costs of collection vehocles

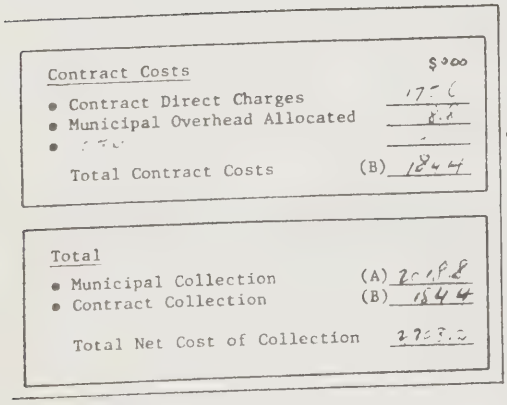
Direct overhead such as foremens wages, travel, training costs, safety supplies, etc.

10% of Direct Labor Costs

For municipally owned vehicles, including depreciation and interest charges (Further instructions in Cost Report)

Other costs not falling into above headings

Revenue for collection service not covered in by-laws



Direct contractor charges for collection services per contract agreement

5% of contract charges

Any other contract related cost not included above

INPUT COMPLETION INSTRUCTIONS

(COLLECTION DATA)

SPARE COLLECTION VEHICLES OR STAND-BY

NORMAL CREW SIZE FOR THE VEHICLE TYPE

COLLECTION VEHICLES NORMALLY IN FULL TIME USE FOR THIS ACTIVITY

FULL TIME
D= DIESEL
G= GAS
(PREDOMINANT FUEL USED)

SAME INFORMATION FOR CONTRACTOR OPERATIONS WHERE AVAILABLE

MANUFACTURERS RATED CUBIC YARDS CAPACITY

VEHICLE TYPE CODES:
RLP=REAR LANDING PACKER
SLP=SIDE LANDING PACKER
FLP=FRONT LANDING PACKER
ST=STAKE TRUCK
DT=DUMP TRUCK
SA=SINGLE AXLE
DA=DUEL AXLE

4. Fleet Description

Vehicle Description		Municipal				Contract			
Type	Size Yds.	# of Units Active	# of Units Spare	Fuel Type	Crew Size	Active	Spare	Fuel Type	Crew Size
RLP	20	10	1	D	3				
RLP	25	16	0	D	3				
RLP	30	2	0	D	3	2	0	-	2
SLP	27	2	0	G	1				

Annual Truck Volume Collected Cubic Yards — Municipal 473,220 — Contract 27,720

Annual Fuel Usage — Gas 4260 — Diesel 96,324

PER FLEET RECORDS

AVERAGE NUMBER OF LOADS PER ANNUM FOR EACH VEHICLE X RATED CUBIC YARDS CAPACITY

DIFFERENCE BETWEEN HOURS ON BEAT AND HAUL VS. HOURS PAID

PER CREW CARD RECORDS

PER CREW CARD RECORDS

5. Labour Productivity

	Municipal	Contract
Hours worked on 'Beat'	95,370	6,212
Hours on Haul	24,677	1,619
Hours not worked	70,577	4
Total Hours Paid	190,624	7,731
Overtime Hours Included Above	7,618	0

SAME INFORMATION FOR CONTRACTOR CREWS IF AVAILABLE

PER PAYROLL RECORDS

PER PAYROLL RECORDS

INPUT COMPLETION INSTRUCTIONS

(COLLECTION DATA)

PER MUNICIPAL COLLECTION ROUTE RECORDS

PREDOMINANT FREQUENCY OF COLLECTION FOR THE TYPE OF ROUTE

COLLECTION AT ONE "PASS" OF THE STREET OR TWO "PASSES"

SAME INFORMATION FOR CONTRACTOR FROM CONTRACT TERMS IF AVAILABLE

6. ROUTE DESCRIPTIONS

Type of Route	Municipal # of Routes	Municipal Freq. of Coll'n	Municipal Point of Pickup	Municipal 1 or 2 Side Col	Contract # of Routes	Contract Freq. of Coll'n	Contract Point of Pickup	Contract 1 or 2 Side Col
Residential	22	1	Curb	2				
Apartment	5	2	Lane	2				
Commercial	3	2	Lane	2	?	2	Lane	2
Res./Apt.	0	-	-	-				
Res/Apt/Comm.	1	2	mixed	2				
Other _____								
Total/ Predominant	31	1	curb	2	?	2	lane	2

PREDOMINANT POINT OF PICK-UP
- C=CURB OR STREET LINE
- FY=FRONT YARD
- RY=REAR YARD
- L/A=LANE OR ALLEY
- B=BULK CONTAINER
- O=OTHER, SPECIFY EG. MIXED

NOTING PREDOMINANT OR NOT KNOWN PRECISELY

THE HIGH, AVERAGE AND LOWEST NUMBER OF PICKUP POINTS ON THE ROUTE. IN THIS CASE ONLY RESIDENTIAL PICK-UP POINTS WERE KNOWN PRECISELY

THE HIGH, AVERAGE AND LOW NUMBER OF CALL ROUTE MILES

SAME INFORMATION FOR THE CONTRACTOR IF AVAILABLE

Numeric Data	Municipal High	Municipal Average	Municipal Low	Contract High	Contract Average	Contract Low
Number of Pick-up Points	~212	3,220	2,206	2,172	[illegible]	2,209
Number of Households	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Call Route Miles	~32	21	.9	?	[illegible]	19
Haul Distance to Disposal	7	7	5	8	7	6
# of Loads per day	[illegible]	2.0	1.5	3.5	2.0	2.8

INFORMATION INDICATING A DIFFERENT NUMBER OF HOUSEHOLDS TO PICK UP POINTS MAY OR MAY NOT BE AVAILABLE

AVERAGE NUMBER OF LOADS PER DAY FROM THE CREW RECORDS

THE HIGH, AVERAGE AND LOW HAUL DISTANCES TO LANDFILL DISPOSALS

INPUT COMPLETION INSTRUCTIONS
(COLLECTION DATA - IF AVAILABLE)

SOME MUNICIPALITIES MAY BE AFFECTED BY MAJOR (10%) INFLUXES OF SUMMER TOURISTS FOR EXAMPLE, THIS KIND OF CHANGE SHOULD BE RECORDED HERE

ENTER THE % OF THE PREDOMINANT TYPES OF COLLECTIONS. EG. 80% RESIDENTIAL BAG OR CAN COLLECTION IN THE EXAMPLE

IN THIS EXAMPLE, THERE ARE SPECIAL MONTHLY COLLECTIONS OF NEWSPRINT

THE RENTAL RATE CHARGED BY THE CENTRAL MAINTENANCE GARAGE, MAY COVER REPAIRS AND MAINTENANCE COSTS FOR THE REPLACEMENT OF VEHICLES

OTHER OPERATING AND PHYSICAL DATA (IF AVAILABLE)

Seasonal Variation in Population (± 10%): When [illegible] ± [ ] %

Type of collection used predominantly:

	Municipal	Contract
Residential - Bag or Can	20	
- Bulk	15	150
- Special Clean-up	5	
- Other ( )	10	
Special Collections carried out	monthly	
Type of Material Newsprint.		

Municipal Vehicle Rental Rate (Predominant) $ 19.70

Vehicle Rental Basic Hour ☑ Day ☐ Week ☐ Minimum Charge ☑

Are collection vehicles used for other purposes: Comment no

ON OCCASSION IN SOME MUNICIPALITIES VEHICLES MAY BE USED BY OTHER DEPARTMENTS AT TIMES. EG. PUBLIC WORKS DEPARTMENT

IN THIS EXAMPLE, THERE IS A MINIMUM CHARGE OF 30 HOURS PER WEEK AT $19.70 PER HOUR FOR EACH COLLECTION VEHICLE

8. OTHER MUNICIPAL CREW DATA

- Collection crew employment system

Hours Per Week Paid 40

Days Per Week Worked 5

- Fixed Hours No Overtime ☐
- Fixed Hours Overtime Paid ☐
- Task incentive, Route Completion ☑
- Task incentive, All Routes Complete ☐
- Other ☐

AS PER THE AGREEMENT IN PLACE WITH THE CREWS

- Number of Crews 30, Number of Foremen 5
- Hourly rates; Driver $7.60, Collection $6.90, Other ( ) $

NORMALLY THE SAME AS THE NUMBER OF ACTIVE COLLECTION VEHICLES

PER THE COLLECTIVE AGREEMENT, OR AVERAGE FOR THE YEAR IF THERE IS A MID-YEAR CONTRACT CHANGE

MUNICIPAL INPUT - SHORT FORM

During the pilot implementation program, one of the municipalities involved was a small rural township of less than 10,000 permanent population. In this case, the clerk-treasurer gathered the necessary information and completed the returns personally since there were no other qualified staff available. It became evident during discussions that the completion of a lenghy "full-return" was cumbersome for this municipality and it was suggested similar reaction would be forthcoming from other smaller municipalities. It was also evident that the solid waste costs and tonnage involved, although significant to the municipality, were of less significance in terms of the province as a whole.

As a result of our review, it is recommended that a "short-form" of municipal return be used, if and when smaller municipalities participate in the costing system), as shown on pages 7 and 8 following. On this return which can cover collection and/or disposal, summarized key data is requested (e.g. tons and costs) with other data that should be readily available also being asked for (e.g., municipal crew size).

It is anticipated that the adoption of the shorter form of input will make the introduction of the system easier in smaller municipalities. The Waste Management Branch should consider introducing this reporting in the future if complete provincial solid waste data is required. Based on the quality and degree of response, the data can then be entered into the provincial reporting system.

Ontario

Ministry of the Environment

WASTE MANAGEMENT BRANCH

SOLID WASTE MANAGEMENT

COSTING SYSTEM

MUNICIPAL INPUT 19__

FOR COLLECTION AND DISPOSAL ACTIVITY

- SHORT FORM -

(MUNICIPALITIES UNDER 10,000 POPULATION)

Description of Municipality

Municipality _____ Code (For.) (Office) (Use) _____

Description (Region, City, Town, etc.) _____

Mailing Address _____

Postal Code _____ Telephone # ( )- _____

Municipal Contacts

Name A. _____ B. _____

Title or Position A. _____ B. _____

1. Collection Information

- Enumerated population _____

- Collection Service:

	Households	Tonnage	Cubic Yardage
Municipally collected:	_____	_____	_____
Contract collected:	_____	_____	_____
Not collected (Res.)	_____	_____	_____

Tonnage Weighed ☐ or Estimated ☐

Cubic Yardage Truck Counted ☐ or Estimated ☐

- Collection Costs:

	Municipal	Contract	Total
Labor		-	
Equipment		-	
Overhead (Direct or Allocated)			
Payments to contractors	-		
Capital Costs (office use only)	_____	_____	_____
Total Costs (office use only	_____	_____	_____
Revenues	_____	_____	_____
Net Cost (office use only)	_____	_____	_____

- Normal crew size ____ Normal pick-up locations ____
- Collection crew manhours per annum; on beat ____, on haul or other ____

2. Disposal Information

- Disposed at another municipality (name) _____
- Disposed at own site ☐
- Tons: - disposed _____, or Cubic Yards - disposed _____

  - Weighed ☐ Estimated ☐ - Counted ☐ or Estimated ☐

- Disposal Costs

	Municipal	Contract	Total
Labor			
Equipment			
Overhead (Direct & Allocated)			
Payments to Contractors			
Capital Costs (office use only)	_____	_____	_____
Total Costs (office use only)	_____	_____	_____
Revenues	_____	_____	_____
Net Cost (office use only)	_____	_____	_____

- Municipal manhours used on landfill site per annum _____

CAPITAL COST ESTIMATES

During the review of municipal financial input it was recognized that each municipality operates under different accounting systems and guidelines. As a result of these known inconsistencies in accounting treatment it was decided to check the adequacy of capital cost calculations. In this sub-section of Appendix III we show an example of the check made of collection cost calculations for one large Borough (Section I), and then review the "benchmark" capital cost estimates that were made for a landfill site Section II) so that unit costs could be computed for use in municipalities where these costs are not readily available.

The following example calculations can be used by Waste Management Branch in future years when municipal data is being checked for validity, so that modified data can be superimposed where necessary to make the provincial reports more meaningful.

I. REVIEW OF ADEQUACY OF MUNICIPAL CAPITAL COST CALCULATIONS FOR COLLECTION FLEET

In the example of Table 1 following we show the calculations made to check the adequacy of one municipality's capital cost calculations.
In summary, the process followed was as follows:

- List the vehicle type and number of each type.
- Calculate the total fleet replacement cost (individual vehicle type replacement costs were supplied by the municipality).
- List the average age of each vehicle type (agreed by review municipal staff).
- Apply an inflation factor that then allows regression to the estimated original cost of each vehicle type ("adjusted" cost column).
- Calculate depreciation based on the adjusted cost and estimated vehicle life.
- Calculate an estimated annual interest cost at 10% based on an average investment in the fleet (50% of adjusted cost).
- Compare the total estimated capital cost with the figure used by the municipality.

In the example shown, the estimated capital cost was $241,000 in 1978 and the figure applied by the municipality for the provincial return was $274,000. Thus, in the short-term, the figures used by the municipality appeared adequate. If the cost of vehicle replacement escalates rapidly over a number of years, frequent upward revisions in the capital cost charges will be required to ensure that the capital charges equate closely to vehicle replacement spending. In this way, the collection service costs will continue to reflect a realistic capital cost element.

II. ESTIMATES OF LANDFILL CAPITAL COSTS WERE REQUIRED

During our review of municipal input for landfill sites, it became evident that many municipalities were unable to complete the capital cost section of input because the costs were not readily available. The principal cause of this data shortfall was that many landfill sites were taken over during "regionalization" and specific landfill site capital costs were not segregated at that time. To offset this lack of data and to improve comparability in the provincial reports, the costs of a new landfill site were examined. A large region of 400,000 plus population is presently completing capital work on a major landfill site and it was felt reasonable to apply the unit capital costs for this site to other municipalities. Table 2 following shows details of the information provided by the region to assist us with this phase of the pilot program.

As shown in the table, the capital costs were segregated between equipment, land, off-site services, and structure and other costs. Estimated average useful lives were placed on each cost segment and annual depreciation costs were calculated. The average investment (50% of cost) and annual interest cost (10% of average investment) were computed and a total estimated annual capital cost of $1,735,000 was calculated. This annual cost was then divided by the average annual number of tons and yards to be landfilled to give unit costs as follows:

- $3.16 per ton landfilled, and
- $1.51 per cubic yard landfilled.

The above unit costs (in 1978 dollars) were then applied to other municipalities landfill tonnage estimates allowing for site acquisition date.

In Table 3 following we show the $3.16 per ton estimate being decreased to the estimated 1973 cost level ($2.02) and then applied to the total tons landfilled. This gives an estimated annual cost of $165,000 for the Northern Region in question.

This method of estimating landfill capital costs is intended to facilitate the calculation of equivalent landfill costs and is not expected to be highly accurate. Use of this simple method, however, does provide an order of magnitude estimate of municipal landfill capital costs that should improve the comparability of the provincial reports.

LARGE METROPOLITAN BOROUGH - REVIEW OF ADEQUACY OF DEPRECIATION/INTEREST ALLOWANCE

Vehicle Cost	#	Replacement Cost Each	Replacement Cost Total	Average Age(1978)	Inflation Factor	Adjusted Cost	Depreciation Life	Depreciation $	Interest	Total Capital Cost
Dump Truck	7	24.0	168.0	5	63.2	106.2	7	15.2		
20 Cu.Yd. PLP Gas	5	38.0	190.0	7	54.2	103.0	7	14.7		
20 Cu.Yd. RLP Diesel	39	38.0	1482.0	3	75.1	1113.0	7	77.9		
25 Cu.Yd. RLP Diesel	4	48.0	192.0	5	63.2	121.3	7	17.3		
30 Cu.Yd. FLP Diesel	6	61.0	366.0	4	68.3	250.0	8	31.3		
						1693.5		156.4	84.7	$241.1
										Estimated
					Figure Used by Municipality					$274.4

APPENDIX III
SECTION B
TABLE 1

REGION OF PEEL

ESTIMATE OF LANDFILL SITE
CAPITAL COST PER TON AND PER CUBIC YARD
- BRITTANIA ROAD LANDFILL SITE
$000

	Mobile Equipment	Land	Offsite Services	Structures and Other Costs	Total
Estimated 1978 Capital Cost	$ 1,200	$ 5,300	$ 2,100	$ 3,900	$12,500
Estimated Life	5 yrs.	13 yrs.	13 yrs.	13 yrs.	-
Annual Straight Line Depreciation	$ 240	$ 408	$ 162	$ 300	$ 1,110
Average Investment	$ 600	$ 2,650	$ 1,050	$ 1,950	$ 6,250
Estimated Interest Cost (Say 10%)	$ 60	$ 265	$ 105	$ 195	$ 625
Estimated Annual Capital Cost	$ 300	$ 673	$ 267	$ 495	$ 1,735
Average Annual:-					
Tonnage 550,000 Cost per ton	$ 0.55	$ 1.22	$ 0.49	$ 0.90	$ 3.16
Average Annual:-					
Yardage, 1,144,923 Cost per Cubic Yard	$ 0.26	$ 0.59	$ 0.23	$ 0.43	$ 1.51

APPENDIX III
SECTION B
TABLE 2

NORTHERN REGION

ESTIMATED LANDFILL CAPITAL COSTS/COSTS PER TON

- Landfill cost per ton - Suburban Region 1978 dollars $ 3.16

- Less inflation factors to equate cost to a 1973 estimated level (date of site acquisition)

Year	Inflation Factor *	Net Value	Cost Per Ton
1978	10%	100.0%	$ 3.16
1977	10%	90.9%	-
1976	10%	82.6%	-
1975	10%	75.1%	-
1974	8%	69.0%	-
1973	8%	63.9%	$ 2.02

- Tons landfilled 1978 were 81,700.

- Estimated capital costs are $2.02 x 81,700 = $165,000 (for use in provincial report)

* Estimated Rates for example purposes.

METROPOLITAN AREA - EXAMPLES OF WORKSHEETS

One of the problems that occurred during pilot implementation was that the metropolitan area municipal staff were unable to complete their data input in the time required due to staff changes and training requirements. Also, data was requested for each facility (six transfer stations, three incinerators, etc.) and the accounting statements were not aligned precisely to the prototype costing system requirements.

Since it was considered important to include the Metropolitan area figures in the pilot program, the consultants agreed to use raw data provided by the municipality and prepare the municipal returns. To help the municipal staff with the preparation of the 1979 return, sample worksheets for a transfer station are included in this Appendix.

The key source document used to prepare the financial input was the monthly cost statement used by the municipality (see Table 1 for example). The major problems encountered in using this data were as follows:

- Operating costs were not broken out between station costs and transfer haul costs.
- The cost detail was extensive but not aggregated under the prototype system headings.
- Capital costs of plant and equipment were not readily available.
- Overhead costs were not allocated between plants.

The basic procedures used to arrive at the cost input required for the new system (as shown on Table 2) were as follows:

1. Operating Costs

   The items on the municipal cost statement were coded (1 = wages and salaries and fringes, etc.) and entered in the total column on Table 2. This then gave total costs for wages and salaries (1), equipment repairs (2), equipment operating (3), overhead direct (4), and contract costs (7).

   These total cost items were then allocated between station and haul on the following bases:

   - Wages and salaries - charge haul for number of drivers, leave remainder in station costs.
   - Equipment repairs and operating costs - allocated based on number of vehicles as shown on Table 3, skewed towards haul (66%)
   - Direct overhead - spread based on labour and salary split.
   - Contract costs - were related directly to haul.

2. Overhead Allocated

The policy as laid out in the Costing Manual was used as follows:

- 10% on direct labour and direct salaries for municipal operations.
- 5% on contract operations.

Further details on the overhead allocations are shown in Appendix III, Schedule E, following.

3. Capital Costs - Vehicles

Table 3 shows details of the capital cost calculations for vehicles in the station and for haul. The type, number of, 1979 capital cost, average age, and average life were supplied by municipal staff.

- Based on the number of units and 1979 estimated cost per unit, column (3), 1979 total cost in $000 was calculated.
- The total 1979 costs were then reduced to estimated adjusted cost levels at time of purchase (6) using the estimated age, and estimated inflation factors for the past ten years.
- Depreciation (7) was calculated using the average useful life (5) and the adjusted cost levels (6).
- Interest cost (8) was estimated at 10% of the average investment in the fleet (50% of adjusted capital purchase cost (6)).

The vehicle capital costs ($20.5M) and ($93.6M) were then transferred to Table 2, operating cost breakdown.

4. Capital Costs - Transfer Station

Estimated capital costs for the example station (Wellington) were calculated using the known capital costs for a later station (Victoria Park), and by regressing using the Southam Construction index back to the approximate date of construction of the Wellington Street station. The adjusted capital cost was then pro-rated down based on tonnage throughput in 1978 to reflect approximate facility rating. Details of calculations were as follows:

	Southam Index		Tonnage		Victoria Capital Cost		Wellington Estimated Capital Cost
Wellington	$\frac{131}{178}$	X	$\frac{46,162}{92,221}$	X	$3,471 M	=	$1,277 M

The estimated Wellington Street capital cost was then spread over an approximate twenty year life for depreciation purposes. Interest cost at 10% of average investment (50% of original cost) was also calculated.

Using similar calculations it should be feasible for municipal staff to prepare municipal input for the costing system for the 1979 year. Hopefully, with more time availability in 1979, municipal staff will be able to enhance the detailed calculation of the figures and gradually improve their accuracy.

APPENDIX VII SECTION C TABLE 1

Year 1978 Facility [illegible] STN Acct. No. 74.2-230-02

Sub-Account	Appro-priation	October 18 (PPE Sept. 26) 19.2 P.P.	Nov. 23 (PPE Nov. 7) 22.2 PP	JAN 4/79 (PPE DEC 19) 25.2??		FINAL EXPEND 1978	Code
alaries & Wages	241.4	181.0	206.3	235.0		326.4	1
3210 Safety	0.3	–	0.5	0.5		0.5	4
3313 Protective Cloth.	0.3	0.9	1.0	1.2		2.4	4
3450 Motor Vehicles	9.0	7.8	9.3	10.2		10.9	–
3451 Heavy Equipment	5.0	2.2	2.4	3.1		4.4	–
3452 New Tires	8.0	7.9	14.5	14.5		14.6	–
3610 Gasoline	–	0.1	0.1	0.1		0.9	4
3620 Diesel (Furnace)		3.4	4.3	5.5	Exempt	7.2	3
3621 Diesel (H.Equip.)	21.0	1.6	1.6	1.6	+ = op.	1.6	4
3622 Diesel (Lic.Equip.)		18.4	22.6	24.9	– = mant	26.7	4
3630 Lubricants	3.0	1.4	1.8	1.8		1.8	4
3632 R & M Cranes	–	–	–	–		–	2
3633 " Scales	–	–	–	–		–	2
3634 " Furnaces	–	–	0.1	–		–	2
3643 Natural Gas	–	–	–	–		–	3
3648 Containers	0.2	0.3	0.6	0.4		0.3	4
3653 Hydro	9.0	5.5	6.1	6.7		7.5	3
3713 Pest/Odour Con.	–	–	–	–		–	4
3980 Water	0.6	0.1	0.1	0.4		0.6	3
3990 Miscellaneous	0.5	0.1	0.2	0.2		0.2	4
3995 R & M Equipment	1.5	3.0	3.3	3.5		3.9	2
3996 " Buildings	0.2	4.2	5.6	5.9		6.9	2
3997 " Grounds	1.0	0.9	0.9	0.9		1.3	2
6110 Pay to Oth.Mun.	–	–	–	–		–	
6150 Realty Tax	–	–	–	–		–	
6332 Travel All.(Cas.)	–	–	–	–		–	
6420 Telephone	0.4	0.3	0.3	0.3		0.6	4
6539 Pest/Odour Con.	0.5	0.4	0.5	0.5		0.6	4
6549 Miscellaneous	0.4	0.1	0.2	0.2		0.3	4
6619 Tires	12.0	4.5	5.7	6.6		7.1	–
6620 Mobile Radios	0.1	0.1	0.1	0.1		0.2	4
6643 Railway Crossing	–	–	–	–		–	
6644 R & M Grounds	0.5	–	–	0.1		0.1	2
6646 Motor Vehicles	49.0	43.5	74.9	80.2		98.3	–
6650 R & M Equipment	4.0	0.1	0.1	0.2		1.2	–
6657 Fire Extinguishers	0.3	0.5	0.5	0.5		0.6	4
6666 Heavy Equipment	17.0	12.3	17.0	17.5		27.1	–
6667 R & M Cranes	–	–	–	–		–	2
6668 " Scales	0.5	1.6	1.6	1.6		1.6	2
6669 " Buildings	31.0	0.1	0.2	0.2		0.2	2
6688 R & M Furnaces	–	–	–	–		–	2
6697 Transfer Haul	1.5	1.0	1.0	1.2		1.5	4
6699 Pay to Prov. (ERRP)	–	–	–	–		–	
6710 Printing	–	–	–	–		–	4
6850 Licences, etc.	–	–	–	–		–	
6939 Protective Cloth.	1.6	1.4	1.7	1.9		2.6	4
6940 Equipment Rental	2.5	2.0	2.0	2.2		2.8	4
6950 Truck Rental	–	–	–	–		–	
Actual	422.3	306.7	387.1	429.7			
						562.9	
Prorated	16.2	311.9	360.6				

4040 Heavy Equipment	–	–	–	–		0.4	
4060 New Equip.(Gen.)	3.0	0.3	0.3	0.5		1.4	
4100 Office Equipment	1.0	–	–	0.7		0.7	
4200 Vehicles	–	–	–	–		0.3	
Total Equipment	4.0	0.3	0.3	1.2		2.8	

Note: "Actual" does not include material or services requisitioned or received but not yet paid for.

METROPOLITAN AREA

OPERATING COST BREAKDOWN

LOCATION: WELLINGTON T/F

COST TYPE	ACTIVITY		TOTAL
	STN	HAUL	
LAB AND SALS. (4x16.7)	298.4	66.8	365.2
EQUIPT. REPAIRS (66x163.6)	68.6	109.0	177.6
EQUIPT. OPERATING (66x31.0)	25.9	20.4	46.3
OVERHEAD DIRECT	9.2	1.9	11.1
OVERHEAD ALLOCATED	36.5	8.0	44.5
CAPITAL COST(20.5 STN 128.0)	148.5	93.6	242.1
CONTRACT COST	-	1.5	1.5
OTHER MUNICIPAL COST			
GROSS COST	587.1	301.2	888.3
REVENUE (D)	57.6	-	57.6
REVENUE (R)	-	-	
NET COST	¢529.5	¢301.2	¢830.7

METROPOLITAN AREA

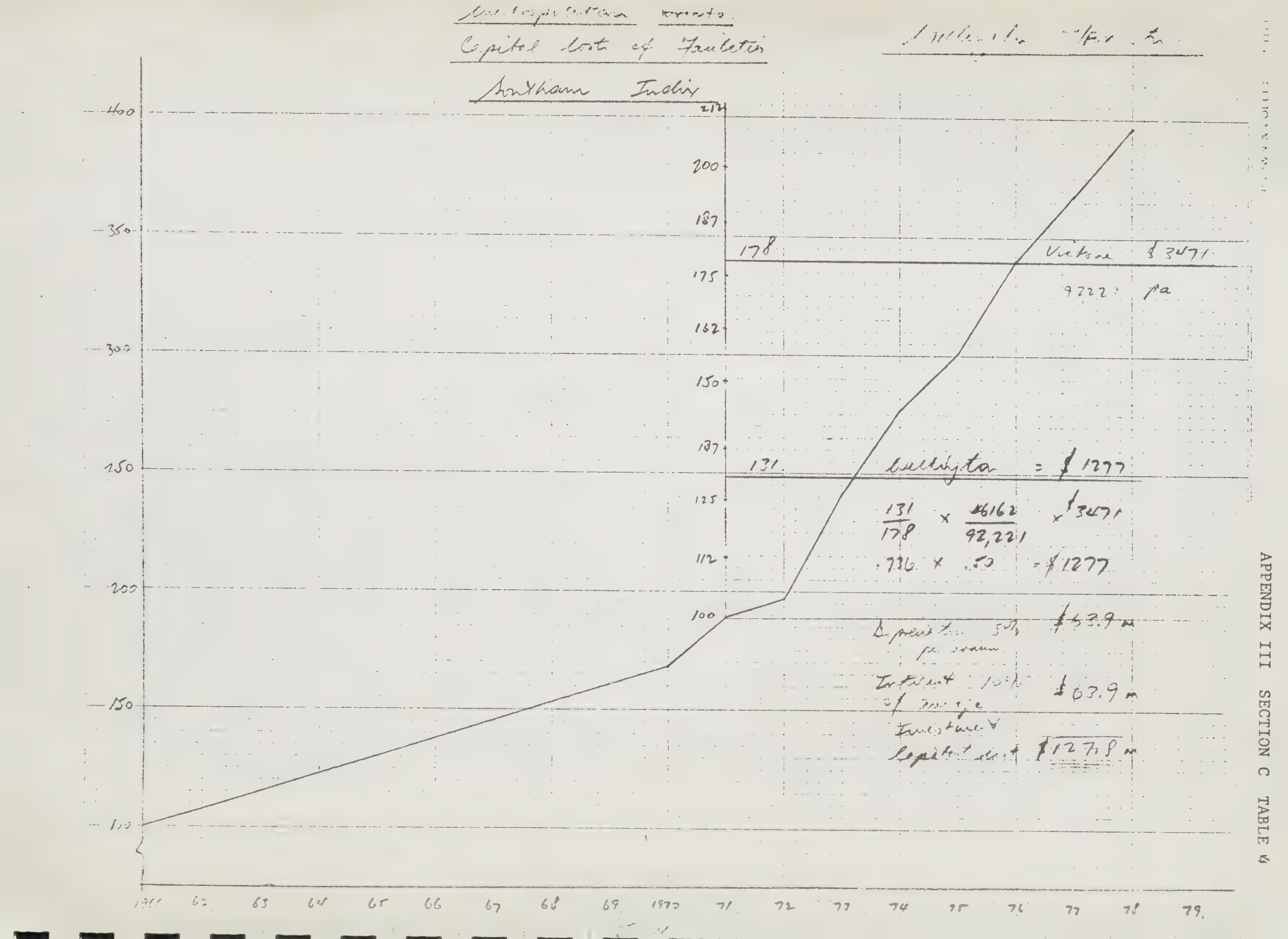
CAPITAL COSTS AND DEPRECIATION CALCULATION

HEAVY EQUIPMENT

LOCATION: WELLINGTON T/FR STN.

EQUIPMENT TYPE 1	# OFF 2	1979 COST. 3	AVERAGE AGE 4	AVERAGE LIFE 5	ADJUST. CAP. COST. 6	DEPRECIATION 7	INTEREST COST 8	CAPITAL CHARGES REPORTED 9
TRAC. CR.	1	80	4 1/2	9				
FEL. 2 YD.	1	50	4 1/2	9	128.3	14.1	6.4	20.5
FEL 3/4	1	15	4 1/2	9				
FEL CR. 3/4	2	50	4 1/2	9				
		195						
				HAULAGE				
TR.TR.	5	475	2 1/2	5	374.3	74.9	18.7	93.6

APPENDIX III
SECTION C
TABLE 3


Capital cost of Facilities
Southern Indiana
400
350
300
250
200
150
214
200
187
178
175
162
150
137
131
125
112
100
Victoria $3471
9222 pa
Gallatin = $1277
131/178 × 46162/92,221 × $3471
.736 × .50 = $1277
Operation 50% $63.9 M
Interest 10% $63.9 M
Facilities $127.8 M
1971 62 63 64 65 66 67 68 69 1970 71 72 73 74 75 76 77 78 79
APPENDIX III SECTION C TABLE 4

OVERHEAD ALLOCATIONS - REVIEW OF REASONABLENESS

One important aspect covered in the review of cost input was an analysis of the reasonableness of the overhead allocations that were included by municipalities. Of the nine municipalities participating, three made no allocation of overheads and the other six made allocations that ranged from 7.6% down to 4.1% of direct labour, and from 5.% to 0.8% of contract costs, as shown in Table 1, following. In our previous report of February, 1978, we suggested that a more reasonable allocation policy would be 10% of direct labour for municipal operations and 5% of contract charges. The intent of these suggested allocation policies was to preclude major variations in the overhead element of the provincial report due to different accounting systems being in place in each of the municipalities.

To test the reasonableness of these policy guidelines, they were applied to each municipality's costs and compared with the actual municipal allocations (see Table 2). Although there were wide variations from the policy allocation levels in individual municipalities, in total for those actually making allocations, the difference in total overhead calculated was $20,000 or 1.6%. Since the object of the provincial report is to make realistic comparisons of accurate well-defined costs, and the overhead allocation section is relatively arbitrary at this point, it was decided to use the policy guidelines to calculate overheads, rather than the figures submitted. When the provincial reporting system becomes established over a number of years, and municipal costing systems are further developed along management accounting principles, it may be more appropriate to use the municipal overhead cost allocation figures.

APPENDIX III
SECTION D
TABLE 1

REVIEW OF ADMINISTRATIVE OVERHEAD ALLOCATIONS

Municipality	Basis of Allocation	Solid Waste Service	$ Allocated	Labour Cost	Contract Cost	% of Labour	% of Contract
Metropolitan Borough (400,000)	None Allocated	Collection:-					
		90% Municipal	Ø	2,948,312	-	Ø	-
		10% Contract	Ø	-	313,632	-	Ø
South Western City	Direct Labour % split of Sanitation Administration overhead only	Collection	71,949	1,697,095	-	4.2%	-
		Landfill	20,240	491,510	-	4.1%	-
Northern City	None Allocated	Collection:					
		90% Municipal	Ø	679,504	-	-	-
		10% Contract	Ø	-	117,542	-	-
Northern Region	None Allocated	Landfill	Ø	-	84,600	-	-
South Western City	% Allocation	Collection	9,980	10,059	1,099,091	0.9%	
		Landfill	15,564	8,131	375,412	4.0%	
		Processing	103,145	154,492	-	66.8%	-
Suburban City	Arbitrary Allocation	Collection	15,000	-	1,892,846	-	0.8%
Suburban Region	Arbitrary Allocation	Landfill:					
		Municipal	116,030	152,614	-	76.0%	
		Contract	55,582		1,023,310	-	5.4%
Rural Township	Arbitrary Allocation	Collection	1,000	-	29,472	-	3.4%
		Landfill	1,000	17,326	-	5.8%	-
Metropolitan Area	Accounting Allocation on Labour Cost	Landfill	217,500	1,832,200	Ø	11.9%	Ø
		Incinerators (Stn.Costs)	306,500	2,515,200	Ø	12.2%	Ø
		Incinerators (Haul Costs)	14,800	116,800	89,000	7.1%	
		Transfer Stn. (Stn.Costs)	243,500	2,141,900	Ø	11.4%	Ø
		Transfer Stn. (Haul Costs)	78,900	501,000	1,224,200	4.6%	

SEGREGATION OF COLLECTION HAUL COSTS FROM ROUTE COSTS

To improve the comparability between municipalities of collection costs per ton it is necessary to take account of the different haul distances to disposal sites from the actual collection routes. Of the sample municipalities involved in pilot implementation, only one, the Northern City, differentiated between haul versus collection route labour hours. (See Table 1 following, Column 1). In this municipalities case the 7 mile haul equated to 10% of the total hours worked by collection crews. Based on this estimated ratio of haul miles to hours on haul, estimates were made of the haul labour hours in the Metropolitan suburb and the South Western City as follows:

- Metropolitan Suburb - 3 mile haul equivalent to 4% of labour hours.
- South Western City - 8 mile haul equivalent to 11.4% of labour hours

Based on the actual or estimated haul labour cost elements in each of the three municipalities, total collection costs were reduced to leave estimated collection route costs. Collection cost per ton was then calculated and compared at the "haul inclusive" and "haul exclusive" cost level as shown on the Table. After the estimated adjustment for haul costs the Northern Cities' cost per ton for collection was in fact lower than that of the Metropolitan Suburb.

It is suggested that Branch staff use the simple haul cost adjustment technique outlined here, to develop more comparable municipal collection route cost figures. Use of these estimated percentages will be necessary until all participating municipalities provide accurate haul versus route collection hours data.

SEGREGATION OF COLLECTION HAUL VS. ROUTE COSTS

	(1) Northern City			(2) Metropolitan Suburb			(3) South Western City		
HOURS PAID	HOURS	%	%	HOURS	%	%	HOURS	%	%
- Beat	32,608	45	90	233,542	74	96E	84,408	44	88.6E
- Haul	4,000	5	10%	9,731	3	4E	10,860	5	11.4E
- Total Worked	36,608	50	100%	243,273	77	100%	95,268	49	100%
- Not worked	35,550	50		72,887	23		98,172	51	
- Total Paid	73,158	100%		316,160	100%		193,440	100%	
Haul Miles to Disposal	7			3			8		
Total Collection Cost - Municipal	$1,011,897			$4,605,908			$3,065,343		
Net of Haul Element	(-10%)910,707			(-4%)4,421,671			(-11.4%)2,715,894		
Tons Collected Municipally	26,775			125,270			97,220		
Cost Per Ton Collected - Excluding haul	$34.01			$35.30			$27.93		
- Including haul	$37.78			$36.78			$31.54		

APPENDIX III
SECTION E
Table 1

TRUCK COUNTING

TABLE OF CONTENTS

SECTION	
A	TRUCK COUNTING FORMS AND PROCEDURES
B	TRUCK COUNTING AT A SMALL RURAL TOWNSHIP
C	CHECK ON TRUCK COUNTS AND SEASONAL FACTORS

TRUCK COUNTING FORMS AND PROCEDURES

These forms and procedures are for use by non-weighing municipalities so that they are able to project the annual solid waste tonnage either collected or disposed of. Four basic forms are provided as follows:

- Sample Truck Count - DAILY LOAD COUNT
- Sample Truck Count - WEEKLY LOAD COUNT SUMMARY
- Sample Truck Count - WEEKLY TONNAGE ESTIMATE
- Calculation of Annual Tonnage Using Sample Truck Count Data.

Details of the procedure for completion of the above forms follow.

1. Daily Load Count (See Table 1 for Example)

   This form is used daily to collect the basic count of sizes and types of vehicles in the sample. Basic data required is as follows:

   - Name of municipality, sample period, type of truck count being carried out (e.g., for collection or disposal operations), and the location of the count.

   - The type of vehicle being counted, as follows:

     - RLP = Rear Loading Packer
     - SLP = Side Loading Packer
     - FLP = Front Loading Packer
     - SP = Stationary Packer
     - R-Off = Roll Off Box
     - S-Box = Lugger Box
     - SA = Single Axle Truck
     - DA = Dual Axle Truck
     - Misc. & 1/2 tons are as stated
     - T/T = Tracter Trailer
     - S/T = Stake Truck and Panel Vans

     These vehicle types are entered in column 1 on the form.

   - Vehicle types are segregated in Column 1 by operator category and type of waste:

     - Municipal vehicles (compacted)
     - Municipal vehicles (loose)
     - Contractors vehicles (compacted) - (Contractor working for a municipality)
     - Contractors vehicles (loose)
     - Private vehicles (compacted)
     - Private vehicles (loose)

- The vehicle capacities (e.g. 20 cubic yards) are entered in column 2.
- The individual loads are recorded in column 3 as vehicles are counted.
- The number of loads are totalled daily in column 4, and a grand total of loads (172) is calculated.

2. Weekly Load Count Summary

This form summarizes the daily load counts so that they can be totalled and cross-added. In the example, the daily load counts (172 loads) prepared on Table 1 are summarized onto this form in column 3. The load counts from subsequent days are then entered in columns 4 to 9 and totalled in column 10 (932 loads).

3. Weekly Tonnage Estimate

This form is used to convert the weekly load counts into a total estimated weight for the week. Basic procedural steps are as follows:

- Carry forward the basic vehicle type and capacity data from Table 2 (columns 1 and 2)
- Carry forward the total weekly load counts from column 10 on Table 2.
- Calculate the total number of cubic yards in the sample by multiplying the number of loads by the vehicle capacities (column 2 x column 3 to give column 4).
- Enter the standard province-wide density factors in Column 5 (from Table 3 of the report).
- Calculate the total weight in kilograms in column 6 (column 4 x column 5)
- Group the total weights in column 7 by operator and type of waste (e.g., municipal/compacted), i.e., by broad categories.
- Enter the seasonal density adjustment percentage in column 8 (percentages taken from Table 4 in the report)
- Calculate the adjusted total weight in kilograms (column 9 = column 7 x column 8) and total the estimated weight (e.g., 2,801,888, kilograms)

4. Calculation of Annual Tonnage Estimate, Using Sample Truck Count Data

In Table 4 we show how the adjusted weekly sample weight (adjusted for seasonal density changes) is converted into an annual tonnage estimate using annualization factors. Key steps in the procedure are as follows:

- In "sample #1" box, the month and duration of sample are entered, and the seasonal adjustment factor (one week in May versus total year) is entered from Table 3 in Appendix I, Schedule D, of the report (2.06% in this case)
- The adjusted total sample weight of 2,801,888 KG (from Table 3) is entered in the sample #1 box.
- This total weight is then pro-rated up to give an annual estimate of tons (136,014 tonnes)
- Example figures are entered in sample boxes #2 and #4, and the results are averaged (135,427 tonnes) and stated in tons (149,281) at the bottom of the form.

The average tons are then used on the municipal form that is input for the provincial report.

Sample Truck Count – DAILY LOAD COUNT

Municipality: City of XYZ — Period of Sample: May 6th 19--

Type of Truck Count: Municipal Collection ☐ Contract Collection ☐ — Landfill Site ☒ — Name of Site: Oakridges Quarry

Vehicle Data: Type	Capacity Cu. Yards	Record of Daily # of Loads	Total Daily Loads
1	2	3	4
Municipal Vehicles (Compactor)			
R&P	25	IIII IIII IIII IIII	18
R&P	20	IIII III	8
F&P	30	IIII IIII II	12
Municipal Vehicles (Misc. Loads)			
SA Dump	5 Ton	III	3
½ Tons	Rec.	IIII IIII IIII IIII IIII IIII IIII IIII II	42
Contractor Vehicles (Compacted)			
Contractor Vehicles (Loose)			
Private Vehicles (Compacted)			
R&P	20	IIII IIII III	13
F&P	30	IIII III	8
F&P	36	IIII II	7
SP	45	IIII I	8
Private Vehicles (Loose)			
R-OH	40	IIII IIII IIII IIII II	22
R-OH	30	IIII IIII IIII	13
L-Box	14	IIII IIII IIII	15
L-Box	12	III	3
TOTAL DAILY LOADS			172

EXAMPLE

FORM No 1509 — 4 SQUARES TO THE INCH — BROWN & COLLETT LTD

Sample Truck Count - WEEKLY LOAD COUNT SUMMARY

Municipality: City of XYZ — Period of Sample: w/e May 10th 19--

Type of Truck Count: Municipal Collection ☐ Contract Collection ☐ — Landfill site ☒ — Name of Site: Oakridge Quarry

Vehicle Type	Data: Capacity Cu. Yards	Monday 6th	Tuesday 7th	Wednesday 8th	Thursday 9th	Friday 10th	Saturday 11th	Sunday 12th	Total Weeks Loads
1	2	3	4	5	6	7	8	9	10
Municipal Vehicles (Compacted)									
R.L.P.	25	18	12	13	Ø	17	Ø		60
R.A.P.	20	8	6	7	Ø	9	Ø		30
F.A.P.	30	12	8	9	Ø	14	Ø		43
Municipal Vehicles (Misc. Loose)									
½ A Dump	5 Ton	3	3	4	3	4	Ø		17
½ Ton	Pick	42	40	32	34	37	67		252
Contractor Vehicles (Compacted)									
Contractor Vehicles (Loose)									
Private Vehicle (Compacted)									
R.L.P.	20	13	13	14	14	12	6		72
F.L.P.	30	8	9	10	8	7	3		45
R.A.P.	30	7	8	8	10	12	6		51
S.P.	40	8	6	6	6	7	22		55
Private Vehicle (Loose)									
P.U.	4½	27	26	24	25	26	10		138
P.U.	3½	13	10	12	13	10	4		62
Car	14	15	17	16	15	9	12		84
Car	12	3	2	4	5	5	6		28
TOTAL LOADS		172	169	159	133	172	136		932

EXAMPLE

Sample Truck Count Summary – WEEKLY TONNAGE ESTIMATE

Municipality: City of XYZ — Period of Sample: one week in ...

Type of Truck Count: Municipal Collection ☐ Contract Collection ☐ — Landfill site ☒ Name of Site: Oakridge Quarry

Vehicle Data: Type	Capacity Cu. Yds.	Number of loads	Total Number of Cubic Yards	Standard Density Factor	Total Weight in KG.	Total Weight by Vehicle Category KG	Seasonal Adjustment Adj.	Adjusted Total Weight
1	2	3	4 = 2 x 3	5	6 = 4 x 5	7	Public Holiday	9 = 7 + 8
Municipal Vehicles (Compacted)								
R & P	25	60	1500	195	292,500			
R & P	20	30	600	217	130,703	679,410	+11.2%	755,...
F & P	30	43	1290	199	256,710			
Municipal Vehicles (Misc. Loose)								
SA Dump	5 Ton	17 Loads	17 Loads	2239	38,063	140,879	X	140,879
½ Ton	Vus	252 Loads	252 Loads	408	102,816			
Contractor Vehicles (Compacted)								
Contractor Vehicles (Loose)								
Private Vehicles (Compacted)								
R & P	20	72	1440	190	273,600			
F & P	30	45	1350	179	241,650		+6.7%	1,1...
F & P	36	51	1836	179	328,644	1110,090		
SP	40	55	2200	121	266,200			
Private Vehicles (Loose)								
R-OH	40	133	5320	66	351,120			
R-OH	30	62	1860	84	156,240	726,096	+13.5%	824,119
L-Box	14	84	1176	120	141,120			
L-Box	12	28	336	231	77,616			
TOTAL WEIGHT SAMPLE							X	2904,774

FORM No. 1509 — 4 SQUARES TO THE INCH — BROWN & COLLETT LTD

Calculation of Annual Tonnage Estimate Using Scale Truck Count Data

Municipality: Elk Lake XYZ

Type of Truck Count: Municipal collection ☐ Landfill Site ☒
Contract for collection ☐ Name of Site Dump

Sample # 1
Month of Sample: May
Length of Sample: 1 week
Seasonal Adj. Factor (Per Tables): 2.06 %

Calculation of Annual Tonnage:
Adjusted Total Sample Weight KG: 2,904,972 × 100% / 2.06 (Seasonal adj. Factor)
Annual Tonnage Estimate = 141,018 Tonnes

Sample # 2
Month of Sample: August
Length of Sample: 1 week
Seasonal Adj. Factor (Per Tables): 1.96 %

Calculation of Annual Tonnage:
Adjusted Total Sample Weight: 2764,815 × 100% / 1.96 (Seasonal adj. Factor)
Annual Tonnage Estimate = 141,062 Tonnes

Sample # 3
Month of Sample: November
Length of Sample:
Seasonal Adj. Factor (Per Tables): 1.98 %

Calculation of Annual Tonnage:
Adjusted Total Sample Weight: 2567,209 × 100% / 1.98 (Seasonal adj. Factor)
Annual Tonnage Estimate = 129,657 Tonnes

Sample # 4
Month of Sample: February
Length of Sample:
Seasonal Adj. Factor (Per Tables): 1.70 %

Calculation of Annual Tonnage:
Adjusted Total Sample Weight: 2294,592 × 100% / 1.70 (Seasonal adj. Factor)
Annual Tonnage Estimate = 134,976 Tonnes

Annual Tonnage Estimate - Averaged

Annual Tonnage Estimate	- Sample # 1	141,018
	- Sample # 2	141,062
	- Sample # 3	129,657
	- Sample # 4	134,976
	Total	546,713
	÷ by # of Samples	4
	= Average Annual Tonnage Estimate	136,678 Tonnes
	× 1.1023 =	150,660 Tons

TRUCK COUNTING EXAMPLE - SMALL RURAL TOWNSHIP

To test the ease with which truck counting techniques could be applied, the concept was tested in February and May, 1979, at a small rural township. Using a simple form (developed when the initial design phase of the costing system was underway), truck counts were made (see Table 1 for an example of the original form). Subsequently, these counts were summarized, and preliminary density factors were applied to give an estimated weekly weight (see Table 2 for examples). The weekly weights were then projected into an annual tonnage figure, in this case taking specific account of summer population increases (see Table 3).

The calculations were reviewed with the municipal staff and were readily comprehended. Subsequently, the forms and procedures for truck counting were updated (see Section A of this Appendix) to allow seasonal density adjustment percentages to be applied.

DATE	REAR END PACKER TRUCK	FORK LIFE PACKER	PRIVATE COLLECTOR ED. HANDY	STAKE TRUCKS (1 TON)	DUMP TRUCKS	1/2 TON TRUCKS	STATION WAGONS	CARS	TRACTOR & WAGON	CAR & TRAILER	OTHER	REMARKS
FEB.12 MONDAY	1		1→B 1→B 1→B 1→M.L.	1→M.L 1→Garbage 1→M.L.	1→Garbage 1→Fille	1→3 1→4—B 1→M.L. 1→M.L. 1→1—B	1→1=B 1→9=B 1→2=B 1→15=B	1→1=B 1→5=B 1→3=B 1→1-B	1→M.L.	1→3=B 1→M.L. 1→20=B		B→means Bags M.L. = means Mixed Loads
												WDS Closed - Collectors with key.
												WDS Closed - Collectors with key.
	1		4	3	2	5	4	4	1	3		TOTAL 27

APPENDIX IV
SECTION B
TABLE 1

TRUCK COUNTING SAMPLE - SMALL RURAL TOWNSHIP (WEEK ENDING FEBRUARY 17, 1979)

* PRELIMINARY ESTIMATE

SUMMARY OF VEHICLE TYPES AND LOADS

TYPE OF VEHICLE	DAY OF WEEK						TOTALS					WEIGHT ESTIMATE	TOTAL* WEIGHT LBS.
	MON	TUES	WEDS	THURS	FRIDAY	SAT	VEHICLES	YARDS	RES. LOAD	MIXED LOAD	BAGS		
RLP 20 Yards													
- Trips	1	2	1	-	1	-	5					(268kg)	
- Loads	20 yd	20 yd	20 yd		20 yd			100				591 lb. yd.	59,100
1 Ton Truck													
- Trips	4	4	-	-	2	-	10					(M2240 lb)	4,480
- Loads	3B 1M	3B 1M			2B				8	2		(R1120 lb)	8,960
1 Ton Stake													
- Trips	3	2	-	-	3	2	10					(M2240 lb)	8,960
- Loads	1B 2M	2B	-	-	2B 1M	1/10B 1M			4	4		(R1120 lb)	4,480
5 Ton Dump Truck													
- Trips	2	1	-	-	1	-	4					(R4200 lb)	4,200
- Loads	1B 1F	1F			1M				1	1		(M8400 lb)	8,400
1/2 Ton Truck										2F		(F11200 lb)	11,200
- Trips	5	4	-	-	8	22	39					(M1120 lb)	14,560
- Loads	8B 2M	12B 2M			29B 1M	68B 8M				13	117	(B 20 lb)	2,340
Station Wagon													
- Trips	4	2	-	-	4	7	17						
- Loads	27B	11B			17B	33B					88	B 20 lb	1,760
Cars													
- Trips	4	6	-	-	6	17	33					(M100 lb)	600
- Loads	10B	20B			19B	57B 6M				6	106	(B 20 lb)	2,120
Tractor & Wagon													
- Trips	1	-	-	-	1	-	2						
- Loads	1M				1M					2		M 500 lb	1,000
Car & Trailer													
- Trips	3	1	-	-	1	2	7					(M 500 lb)	2,000
- Loads	23B 1M	1M			1M	1M				4	32	(B 20 lb)	640
												(60 tons)	134,800

APPENDIX IV
SECTION B
TABLE 2

TRUCK COUNTING SAMPLE - SMALL RURAL TOWNSHIP

CALCULATION OF ANNUAL SOLID WASTE TONNAGE

	# Tons
1. Resident Population - All Year	
• Estimated weight of one week truck counting sample in February 1979 = 60 Tons	
• Factor for 1 week in February from Metropolitan Toronto is 1.70%	
• Estimated annual tonnage for resident population	
$60 \text{ Tons} \times \frac{100.0}{1.7\%} =$	3,529
2. Summer Population	
• Extra 5 loads by 20 cubic yard packer = 59,100 lbs per week	
• From mid-May to mid-September, say 16 weeks	
• Estimated additional summer tonnage 16 x 59,100	422
Total Estimated Annual Tonnage	3,951

REVIEW OF MUNICIPAL TRUCK COUNTS AND TONNAGE ESTIMATES

During the review of truck counting procedures, data was made available that enabled a check to be made on the validity of municipal tonnage estimates. One major suburban region provided truck count data for February and May, 1979, and density factors were applied as shown in Tables 1 and 2 following. The computed weights were then compared with the municipal estimates; in February the computed weight was 7.3% higher than the municipal estimate and in May, was 19.5% higher than the municipal estimate. This apparent underestimation of tonnage, derived by applying density factors, confirmed concerns in the municipality that the actual tonnage landfilled was being underestimated.

APPENDIX IV
SECTION C
TABLE 1

CONFIRMATION OF ESTIMATED TRUCK COUNTING DENSITIES FOR FEBRUARY 1978

Category	Vehicle Type	Cubic Yards	# of Loads	Total Cubic Yards	Density Factor kg per cubic yd	Total kg		Estimated Weight in Tons	
								Per Factors	Per Region
A.	RLP	20	118	2,360	268	632,480)			
	RLP	25	246	6,150	297	1,826,550)	2,641,610	2,912	1,970
	FLP	34	50	1,020	179	182,580)			
B.	RLP	20	40	800	268	214,400)	236,790	261	250
	SAM	Load	10	-	2,239	22,390)			
C.	Misc. Res.	Load	257	-	100		2,570	3	13
D.	Misc. Non-Res.	Load	26	-	500		1,300	1	15
E.	SA Region	Load	95	-	2,239		212,705	234	108
F.	LB	12	239	2,868	176		504,768	556	361
G.	Roff	20	303	6,060	248		1,502,880	1,657	573
H.	Roff	30	203	6,090	127		773,430	853	652
I.	Roff	40	468	18,720	71		1,329,120	1,465	2,120
J.	RLP	15	14	210	179		37,590	41	53
K.	RLP	22½	23	517	179		92,543	102	113
L.	RLP	27½	17	467	179		83,593	92	106
M.	FLP	32½	197	6,402	167		1,069,134	1,179	1,489
N.	FLP	37½	169	6,337	167		1,058,279	1,167	1,501
O.	FLP	40	120	4,800	167		801,600	884	1,309
	TOTAL TONNES BASED ON DENSITY FACTORS						10,347,912	11,407 (+7.3")	10,633

APPENDIX IV
SECTION C
TABLE 2

CONFIRMATION OF ESTIMATED TRUCK COUNTING DENSITIES FOR MAY 1978

Category	Vehicle Type	Cubic Yards	# of Loads	Total Cubic Yards	Density Factor kg per cubic yd	Total kg		Estimated Weight in Tons: Per Factors	Estimated Weight in Tons: Per Region
A.	RLP	20	191	3,820	268	1,023,760)			
	RLP	25	397	9,925	297	2,947,725)	4,263,613	4,700	3,180
	FLP	34	48	1,632	179	292,128)			
B.	RLP	20	80	1,600	268	428,800)			
	SAM	Load	20	-	2,239	44,780)	473,580	522	495
C.	Misc. Res.	Load	609	-	100		60,900	67	30
D.	Misc. Non-Res.	Load	44	-	500		22,000	24	25
E.	SA Region	Load	82	-	2,239		183,598	202	93
F.	LB	12	408	4,896	276		861,696	950	616
G.	Roff	20	372	7,440	248		1,845,120	2,034	703
H.	Roff	30	204	6,120	127		777,240	857	655
I.	Roff	40	548	21,920	71		1,556,320	1,716	2,482
J.	RLP	15	28	420	179		75,180	83	106
K.	RLP	22½	35	788	179		141,052	155	172
L.	RLP	27½	63	1,732	179		310,028	342	392
M.	RLP	32½	187	6,078	167		1,015,026	1,119	1,414
N.	FLP	37½	145	5,438	167		908,146	1,001	1,288
O.	FLP	40	153	6,120	167		1,022,040	1,127	1,669
							13,515,539 (kg)	14,899	13,320
	ADJUSTED FOR SEASONAL DENSITY CHANGE						14,442,327 (kg)	15,919 Tons (+19.5%)	13,320 Tons

TABLE OF CONTENTS

TABLE/S	
1 - 9	PROVINCIAL MONITORING REPORTS PRODUCED MANUALLY
10 - 12	SUMMARY INFORMATION FOR OTHER LARGE MUNICIPALITIES (10,000 PLUS POPULATION), NOT INCLUDED IN SAMPLE

PROVINCIAL MONITORING REPORT

A. FOR ALL MUNICIPALITIES

1. WASTE GENERATION

	MUNICIPAL WASTE GENERATION RATE		TONNAGE COLLECTED AND DISPOSED								TOTAL CUBIC YARDS COLLECTED AND DISPOSED	
	1	2	3	4	5	6	7	8	9	10	11	12
MUNICIPALITY	MUNICIPALLY COLLECTED POUNDS PER HOUSEHOLD	MUNICIPALLY COLLECTED CUBIC YARDS PER HOUSEHOLD	TONS COLLECTED MUNICIPAL AND CONTRACT	TONS COLLECTED, INDUSTRIAL	TONS COLLECTED PRIVATELY, BY INDIVIDUALS AND FROM OTHER SOURCES	TONS COLLECTED FROM OTHER MUNICIPALITIES	TOTAL TONS GENERATED	TONS LANDFILL	TONS INCINERATION MINUS TONS ASH	TOTAL TONS RECOVERED	TOTAL CUBIC YARDS MUNICIPALLY COLLECTED	TOTAL CUBIC YARDS MUNICIPALLY DISPOSED
SOUTH WESTERN CITY	3,215	6.32 E	97,220	0	96,677	0	193,897	193,897	0	0	428,143 E	955,990 E
METROPOLITAN BOROUGH	2,194	2.82 E x	153,570	0	0	0	153,570	0	0	0	394,680 E	0
NORTHERN CITY	1,925	2.75 E	29,075	0	52,625	0	81,700	0	0	0	83,160 E	0
SOUTH EASTERN CITY	1,786	2.55 E	39,438 E	0	40,783 E	0	80,221 E	78,968 E	0	1,253	112,700 E	213,086 E
NORTHERN REGION	0	0	0	0	0	0	81,700	81,700	0	0	0	108,630
RURAL TOWNSHIP	2,119	3.26 E	1,974 E	0	1,977 E	0	3,951 E	3,951 E	0	0	6,800 E	14,329 E
METROPOLITAN AREA	0	0	0	0	0	0	2,019,736	1,686,624	239,965	16,428	0	15,865,528
SUBURBAN REGION	0	0	0	0	0	0	368,796	368,796	0	0	0	434,810 E
SUBURBAN CITY	1,972	4.76 E x	88,560	0	0	0	88,560	0	0	0	427,346	0

APPENDIX V
TABLE 1

PROVINCIAL MONITORING REPORT

A. FOR ALL MUNICIPALITIES

2. SUMMARY OF COSTS AND REVENUES

		SOLID WASTE COSTS AND REVENUES IN DOLLARS					SOLID WASTE COSTS AND REVENUES IN DOLLARS PER TON					SOLID WASTE COSTS AND REVENUES IN DOLLARS PER CUBIC YARD	
	1	2	3	4	5	6	7	8	9		10	11	12
MUNICIPALITY	TOTAL POPULATION	MUNICIPAL COLLECTION COST	MUNICIPAL DISPOSAL COST	LESS RESOURCE RECOVERY (REVENUE)	INDUSTRIAL DISPOSAL (REVENUE)	MUNICIPAL COLLECTION AND DISPOSAL COST LESS ALL REVENUES	GROSS MUNICIPAL AND CONTRACT COLLECTION COST PER TON	MUNICIPAL LANDFILL COST PER TON	MUNICIPAL RESOURCE RECOVERY COST PER TON COLL	DISP	MUNICIPAL (REVENUE) PER TON DISPOSED BY INDUSTRY	GROSS MUNICIPAL COLLECTION COST PER CUBIC YARD E	GROSS MUNICIPAL DISPOSAL COST PER CUBIC YARD E
SOUTH WESTERN CITY	253,726	3,065,343	1,685,454	0	451,417	4,299,380	31.54	8.69	0	0	4.67	7.15	1.76
METROPOLITAN BOROUGH	410,000	4,935,222	0	96,479	0	4,838,743	32.14	0	N/A	N/A	0	12.50	0
NORTHERN CITY	94,204	1,135,316	0	0	0	1,135,316	39.04	0	0	0	0	13.65	0
SOUTH EASTERN CITY	124,304	1,171,365	984,684	7,221	57,492	2,091,336	29.70	8.95	0	6.87	1.46	10.39	4.62
NORTHERN REGION	94,204	0	294,400	0	0	294,400	0	3.60	0	0	0	0	2.71
RURAL TOWNSHIP	9,500	30,945	28,493	0	0	59,438	15.67	7.21	0	0	0	4.55	1.99
METROPOLITAN AREA	2,137,787	0	18,253,500	65,800	4,789,400	13,398,300	0	2.91	0	0	8.32	0	1.15
SUBURBAN REGION	421,618	0	1,934,778	0	1,302,812	631,966	0	5.25	0	0	6.05	0	4.45
SUBURBAN CITY	273,467	2,031,988	0	0	0	2,031,988	0	0	0	0	0	4.75	0

APPENDIX V
TABLE 2

PROVINCIAL MONITORING REPORT

A. FOR ALL MUNICIPALITIES

3. COLLECTION COSTS

	SCALE OF SERVICE			MUNICIPAL AND CONTRACT COSTS AND REVENUES PER TON							
	1	2		3	4	5	6	7	8	9	10
MUNICIPALITY	TOTAL HOUSEHOLDS	% OF TOTAL HOUSEHOLDS COLLECTED BY MUN	CONTR	DIRECT LABOUR PER TON (INCLUDING BENEFITS)	EQUIPMENT OPERATING PER TON	OVERHEAD PER TON	CAPITAL COST PER TON	CONTRACT PER TON	EXTERNAL COLLECTION (REVENUE PER TON	DIRECT LABOUR EQUIPMENT OPERATING & CAPITAL COST PER 1,000 TON MILES	TOTAL GROSS MUNICIPAL COLLECTION & DISPOSAL COST PER HOUSEHOLD
SOUTH WESTERN CITY	67,745	100	0	17.46	7.57	4.35	2.16	0	0.61	N/A	70.13 C&D
METROPOLITAN BOROUGH	140,000	90	10	23.54	6.50	4.55	2.19	11.64	0	N/A	35.25 C
NORTHERN CITY	30,200	90	10	25.38	6.63	3.84	1.93	53.66	0	5.56	37.59 C
SOUTH EASTERN CITY	44,170	0	100	0	0	0	0	29.70	0	0	48.81 C&D
NORTHERN REGION	30,200	0	0	0	0	0	0	0	0	0	9.74 D
RURAL TOWNSHIP	2,087	0	69	0	0	0	0	15.66	0	0	28.48 C&D
METROPOLITAN AREA	913,865	0	0	0	0	0	0	0	0	0	19.97 D
SUBURBAN REGION	138,462 E	0	0	0	0	0	0	0	0	0	13.97 D
SUBURBAN CITY	89,804	0	100	0	0	0	0	22.94	0	N/A	22.63 C

C = Collection
D = Disposal

APPENDIX V
TABLE 3

PROVINCIAL MONITORING REPORT

A. FOR ALL MUNICIPALITIES

4. LANDFILL COSTS

	MUNICIPAL AND CONTRACT COSTS AND REVENUES PER TON							MUNICIPAL ENERGY USE		
	1	2	3	4	5	6	7	8	9	10
MUNICIPALITY	DIRECT LABOUR PER TON (INCLUDING BENEFITS)	EQUIPMENT OPERATING PER TON	OVERHEAD PER TON	CAPITAL COST PER TON	CONTRACT COST PER TON	OTHER MUNICIPAL COST PER TON	EXTERNAL (REVENUE) PER TON DISPOSED	TONS RESOURCE RECOVERY IN DISPOSAL	GALLONS OF FUEL PER MILLION TON MILES COLLECTED	GALLONS OF FUEL PER TON LANDFILLED
SOUTH WESTERN CITY	2.53	2.02	1.72	2.24 E	0	0.18	4.06	0	N/A	0.14
METROPOLITAN BOROUGH	0	0	0	0	0	0	0	0	N/A	0
NORTHERN CITY	0	0	0	0	0	0	0	0	N/A	N/A
SOUTH EASTERN CITY	0.10	0.02	0.23	3.60	4.99	0	1.46	1,253	N/A	N/A
NORTHERN REGION	0	0	0.50	2.02 E	1.09	0	0	0	0	N/A
RURAL TOWNSHIP	4.39	1.55	0.94	0.38	0	0	0	0	0	0.34
METROPOLITAN AREA	1.09	0.48	0.27	0.99 E	0	0.08	7.68	0	0	N/A
SUBURBAN REGION	1.01	0.59	2.08	2.02 E	4.93	0	6.05	0	0	0.21
SUBURBAN CITY	0	0	0	0	0	0	0	0	N/A	0

PROVINCIAL MONITORING REPORT

A. FOR ALL MUNICIPALITIES

5. PRODUCTIVITY AND OPERATING CHARACTERISTICS

	MUNICIPAL PRODUCTIVITY INDICATORS					MUNICIPAL OPERATING CHARACTERISTICS											
	1	2	3	4	5	6		7		8		9		10		11		
MUNICIPALITY	COLLECTION ROUTE MAN HOURS PER TON	COLLECTION VEHICLE REPAIR + MAINTENANCE COST PER TON	CUBIC YARDS OF ACTIVE COLLECTION VEHICLE CAPACITY PER 1,000 HOUSEHOLDS	COLLECTION DOLLARS CAPITAL PER 1,000 HOUSEHOLDS	TOTAL LANDFILL MAN HOURS PER TON	RESIDENTIAL COLLECTION FREQUENCY PER WEEK MUN	CONTR	PREDOMINANT POINT OF RESIDENTIAL COLLECTION MUN	CONTR	AVERAGE CREW SIZE INCLUDING DRIVER MUN	CONTR	HOUSEHOLDS PER MILE OF COLLECTION ROUTE MUN	CONTR	AVERAGE CENTROID MILES TO DISPOSAL SITE MUN	CONTR	NUMBER OF LANDFILL SITES MUN	CONTR	OTHER
SOUTH WESTERN CITY	0.98	6.44	9.4	8.745	0.44	1	0	C	0	2.8	0			8	-	2	0	0
METROPOLITAN BOROUGH	N/A	5.43	10.6	1,960	0	2	2	C	C	2	2	N/A	N/A	3	3	0	0	0
NORTHERN CITY	1.22	5.68	6.6	3,977	0	2	2	C	C	3	1.5	32	N/A	7	7	0	0	0
SOUTH EASTERN CITY	0	0	5.8	0	0	0	1	0	RY	0	2	0	22.6	0	4	2	0	0
NORTHERN REGION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
RURAL TOWNSHIP	0	0	0	0	0.58	0	1	0	C	0	2	0	10	0	9	1	0	0
METROPOLITAN AREA	0	0	0	0	0.05	0	0	0	0	0	0	0	0	0	0	4	0	0
SUBURBAN REGION	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0	0	3	1	0
SUBURBAN CITY	0	0	0	0	0	0	1.5	0	C	0	2	0	N/A	0	N/A	0	0	0

APPENDIX V
TABLE 5

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES - 1980
C. INCINERATORS
1. SUMMARY OF QUANTITIES, COSTS AND REVENUES

	QUANTITY OF WASTE PROCESSED				COSTS AND REVENUE PER TON				COSTS AND REVENUE PER CUBIC YARD			
	1	2	3	4	5	6	7	8	9	10	11	12
MUNICIPALITY	TOTAL TONS INCINERATED	TOTAL TONS RESIDUE	TOTAL CUBIC YARDS INCINERATED	TOTAL CUBIC YARDS RESIDUE	INCINERATION	TRANSPORT	INDUSTRIAL DISPOSAL (REVENUE)	TOTAL LESS REVENUE	INCINERATION	TRANSPORT	INDUSTRIAL DISPOSAL (REVENUE)	TOTAL LESS REVENUE
	343,111	106,146	N/A	N/A	15.03	5.27	8.25	8.40	N/A	N/A	N/A	N/A

C. INCINERATORS
2. INCINERATION AND TRANSPORT COST PER TON

	INCINERATION COST PER TON					TRANSPORT COST PER TON				TRANSPORTATION		
	1	2	3	4	5	6	7	8	9	11	12	
MUNICIPALITY	DIRECT LABOUR	EQUIPMENT OPERATING	OVERHEAD	CAPITAL	CONTRACT	DIRECT LABOUR	EQUIPMENT OPERATING	OVERHEAD	CAPITAL	CONTRACT	TRANSPORT COST PER 1000 TON MILES	AVERAGE MILES TO FINAL DISPOSAL SITE
	7.33	3.09	0.84	3.76	-	1.10	1.20	0.13	1.95	0.84	216.76	24.3

C. INCINERATORS
3. PRODUCTIVITY AND OPERATING CHARACTERISTICS

	MUNICIPAL PRODUCTIVITY INDICATORS								OPERATING CHARACTERISTICS			
	1	2	3	4	5	6	7	8	9	10	11	12
	INCINERATOR				TRANSPORT							
MUNICIPALITY	DIRECT LABOUR HOURS PER TON	EQUIPMENT REPAIRS AND MAINTENANCE COST PER TON	TONNAGE CAPACITY PER HOUR FULL SHIFT	DOLLARS OF CAPITAL INVESTED PER TON	DIRECT LABOUR HOURS PER TON	VEHICLE REPAIRS AND MAINTENANCE COST PER TON	STANDING CUBIC YARDS OF VEHICLE CAPACITY	DOLLARS OF CAPITAL INVESTMENT PER TON	NUMBER OF INCINERATORS MUN CONTR	NUMBER OF FINAL DISPOSAL SITES MUN CONTR	AVERAGE OPERATING INCINERATION HOURS/WEEK MUN CONTR	AVERAGE OPERATING TRANSPORT HOURS/WEEK MUN CONTR
	0.69	0.94	51.5E	18.29	0.14	1.00	N/A	N/A	3 0	4 0	128 -	N/A N/A

C. INCINERATORS
4. RESOURCE CONSUMPTION

	1	2	3
MUNICIPALITY	INCINERATOR GALLONS OF FUEL PER TON INCINERATED	GALLONS OF WATER PER TON INCINERATED	TRANSPORT GALLONS OF FUEL PER 1,000 TON MILES HAULED
	N/A	N/A	6.3

APPENDIX V
TABLE 6

METROPOLITAN TORONTO

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
B. TRANSFER STATIONS
1. SUMMARY OF QUANTITIES, COSTS AND REVENUES

	QUANTITY OF WASTE PROCESSED		COSTS AND REVENUES PER TON				COSTS AND REVENUES PER CUBIC YARD				TRANSPORTATION	
	1	2	3	4	5	6	7	8	9	10	11	12
MUNICIPALITY	TOTAL TONS TRANSFERRED	TOTAL CUBIC YARDS TRANSFERRED	STATION	TRANSPORT	INDUSTRIAL DISPOSAL (REVENUE)	TOTAL LESS REVENUE	STATION	TRANSPORT	INDUSTRIAL DISPOSAL (REVENUE)	TOTAL LESS REVENUE	TOTAL TRANSPORT COST/100 TON MILES	AVERAGE MILES TO FINAL DISPOSAL SITE
	795,797		5.47	4.12	9.03	0.56					170.35	24.2

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
B. TRANSFER STATIONS
2. STATION AND TRANSPORT COST PER TON

	STATION COST PER TON					TRANSPORT COST PER TON					ENERGY USE	
	1	2	3	4	5	6	7	8	9	10	11	12
MUNICIPALITY	DIRECT LABOUR	EQUIPMENT OPERATING	OVERHEAD	CAPITAL	CONTRACT	DIRECT LABOUR	EQUIPMENT OPERATING	OVERHEAD	CAPITAL	CONTRACT	STATION GALLONS OF FUEL PER TON	TRANSPORT GALLONS OF FUEL PER 1000 TON MILES
	2.69	0.85	0.34	1.59	-	1.24	2.06	0.15	1.48	3.29	N/A	6.58

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
B. TRANSFER STATIONS
3. PRODUCTIVITY AND OPERATING CHARACTERISTICS

	MUNICIPAL PRODUCTIVITY INDICATORS								OPERATING CHARACTERISTICS			
	1	2	3	4	5	6	7	8	9	10	11	12
	STATION				TRANSPORT							
MUNICIPALITY	DIRECT LABOUR HOURS PER TON	EQUIPMENT REPAIRS AND MAINTENANCE COST PER TON	TONNAGE CAPACITY PER HOUR FULL SHIFT	DOLLARS OF CAPITAL INVESTMENT PER TON	DIRECT LABOUR HOURS PER TON	VEHICLE REPAIRS AND MAINTENANCE COST PER TON	STANDING CUBIC YARDS OF VEHICLE CAPACITY	DOLLARS OF CAPITAL INVESTMENT PER TON	NUMBER OF TRANSFER STATIONS MUN CONTR	NUMBER OF FINAL DISPOSAL SITES MUN CONTR	AVERAGE OPERATING STATION HOURS/WEEK MUN CONTR	AVERAGE OPERATING TRANSPORT HOURS/WEEK MUN CONTR
	0.25	1.14	306	7.53	0.15	1.64	2400	2.96	9 -	4 -	45 -	50 -

TABLE [illegible]

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
D. RESOURCE RECOVERY FACILITIES
1. SUMMARY OF QUANTITIES, PROCESSED, RECOVERED, SOLD
PROCESSED USED AND RESOURCES RECOVERED

QUANTITY OF WASTE PROCESSED AND RECOVERED

	1	2	3	4	5	6		7		8		9	
MUNICIPALITY	TOTAL TONS PROCESSED	TOTAL TONS RECOVERED	% TONS RECOVERED THAT ARE SOLD	TOTAL CUBIC YARDS PROCESSED	TOTAL CUBIC YARDS RECOVERED	MAJOR RECOVERY PROCESSED USED (LIST) MUN	CONTR	TYPE OF RESOURCES RECOVERED (CODE) MUN	CONTR	AVERAGE NUMBER OF MILES TO FINAL DISPOSAL SITE MUN	CONTR	AVERAGE NUMBER OF MILES TO RESOURCE BUYER MUN	CONTR
SOUTH EASTERN CITY	39,438	1,253	100	112,700	N/A	M/R		F	0	0	0	35	

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
D. RESOURCE RECOVERY FACILITIES
2. SUMMARY OF COSTS AND REVENUES PER TON AND PER CUBIC YARD

	COST AND REVENUES PER TON					COSTS AND REVENUES PER CUBIC YARD				
	1	2	3	4	5	6	7	8	9	10
MUNICIPALITY	RECOVERY	WASTE TRANSPORT TO FINAL DISPOSAL	OTHER INDUSTRIAL DISPOSAL (REVENUE)	RECOVERY REVENUE AFTER TRANSPORT COST	TOTAL LESS ALL REVENUES	RECOVERY	WASTE TRANSPORT TO FINAL DISPOSAL	INDUSTRIAL DISPOSAL (REVENUE)	RECOVERY REVENUE AFTER TRANSPORT COST	TOTAL LESS ALL REVENUES
SOUTH EASTERN CITY	7.06	0	0	5.76	6.87	2.47	0	0	N/A	2.40

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
D. RESOURCE RECOVERY FACILITIES
3. RECOVERY AND TRANSPORT COST PER TON

	RECOVERY COST PER TON					WASTE TRANSPORT COST TO FINAL DISPOSAL PER TON					TRANSPORT COST PER TON OF RESOURCES RECOVERED		
	1	2	3	4	5	6	7	8	9	10	11	12	
MUNICIPALITY	DIRECT LABOUR	EQUIPMENT OPERATING	OVERHEAD	CAPITAL	CONTRACT	DIRECT LABOUR	EQUIPMENT OPERATING	OVERHEAD	CAPITAL	CONTRACT	MUNICIPAL	CONTRACTED OR OTHER	
SOUTH EASTERN CITY	3.91	0.68	1.03	1.42	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

APPENDIX V
TABLE 8

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
D. RESOURCE RECOVERY FACILITIES
4. MUNICIPAL PRODUCTIVITY INDICATORS

	RECOVERY				TRANSPORT TO FINAL DISPOSAL POINT				TRANSPORT COST/1000 TON MILES TO	
	1	2	3	4	5	6	7	8	9	10
MUNICIPALITY	DIRECT LABOUR HOURS PER TON	EQUIPMENT REPAIRS AND MAINTENANCE COST PER TON	TONNAGE CAPACITY PER HOUR FULL SHIFT	DOLLARS OF CAPITAL INVESTED PER TON	DIRECT LABOUR HOURS PER TON	VEHICLE REPAIRS AND MAINTENANCE COST PER TON	STANDING CUBIC YARDS OF VEHICLE CAPACITY	DOLLARS OF CAPITAL INVESTED PER TON	FINAL DISPOSAL SITE	RESOURCE BUYER
SOUTH EASTERN CITY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PROVINCIAL MONITORING REPORT
FOR MUNICIPALITIES WITH
D. RESOURCE RECOVERY FACILITIES
5. OPERATING CHARACTERISTICS AND ENERGY USE

	OPERATING CHARACTERISTICS								ENERGY USE		
	1		2		3		4		5	6	7
MUNICIPALITY	NUMBER OF RECOVERY FACILITIES MUN	CONTR	NUMBER OF FINAL DISPOSAL SITES MUN	CONTR	NUMBER OF RESOURCE BUYERS MUN	CONTR	AVERAGE OPERATING RECOVERY HOURS PER WEEK MUN	CONTR	RECOVERY GALLONS OF FUEL PER TON	TRANSPORT GALLONS OF FUEL PER 1000 TON MILES TO FINAL DISPOSAL SITE	TRANSPORT GALLONS OF FUEL PER 1000 TON MILES TO RESOURCE BUYER
SOUTH EASTERN CITY	1	0	1	0	1	0	N/A	0	N/A	N/A	N/A

APPENDIX V
TABLE 9

APPENDIX V
TABLE 10

	CODE#	NAME OF MUNICIPALITY	NET MUN COLL'N COST PER TON	NET MUN DISP COST PER TON	NET RECOVERY REVENUE/TON	NET IND DISP REV PER TON	MUN COL'N COST PER CUBIC YAR	MUN LANDFILL COST PER CU YD
# 1	01101		39.99	0.00	0.00	0.00	0.00	0.00
# 2	01201		32.28	0.00	0.00	0.00	0.00	0.00
# 3	01203		22.97	0.00	0.00	0.00	0.00	0.00
# 4	01204		30.91	0.00	0.00	0.00	0.00	0.00
# 5	01205		35.97	0.00	0.00	0.00	0.00	0.00
# 6	10000		0.00	6.36	0.00	0.00	0.00	0.00
# 7	10101		23.94	0.00	0.00	0.00	0.00	0.00
# 8	10401		22.10	3.17	0.00	0.00	0.00	0.00
# 9	10402		18.58	0.00	0.00	0.00	0.00	0.00
# 10	10403		24.39	0.00	0.00	0.00	0.00	0.00
# 11	10404		22.48	0.00	0.00	0.00	0.00	0.00
# 12	10602		12.29	0.00	0.00	0.00	0.00	0.00
# 13	10603		17.74	0.00	0.00	0.00	0.00	0.00
# 14	12000		0.00	6.66	0.00	0.00	0.00	0.00
# 15	12101		15.42	0.00	0.00	0.00	0.00	0.00
# 16	12401		11.96	0.00	0.00	0.00	0.00	0.00
# 17	12402		11.93	0.00	0.00	0.00	0.00	0.00
# 18	12403		22.84	0.00	0.00	0.00	0.00	0.00
# 19	12601		16.42	0.00	0.00	0.00	0.00	0.00
# 20	12602		14.11	0.00	0.00	0.00	0.00	0.00
# 21	14000		0.00	5.04	0.00	0.00	0.00	0.00
# 22	14101		24.51	0.00	0.00	0.00	0.00	0.00
# 23	14401		13.76	3.28	0.00	0.00	0.00	0.00
# 24	14402		17.93	2.65	0.00	0.00	0.00	0.00
# 25	14403		26.18	3.67	0.00	0.00	0.00	0.00
# 26	16000		0.00	11.01	0.00	0.00	0.00	0.00
# 27	16101		17.60	0.00	0.00	0.00	0.00	0.00
# 28	16401		17.52	0.00	0.00	0.00	0.00	0.00
# 29	16402		21.33	0.00	0.00	0.00	0.00	0.00
# 30	16403		26.05	0.00	0.00	0.00	0.00	0.00
# 31	16601		18.68	0.00	0.00	0.00	0.00	0.00
# 32	16602		28.57	0.00	0.00	0.00	0.00	0.00
# 33	18101		37.65	5.49	0.00	0.00	0.00	0.00
# 34	18102		21.08	7.31	0.00	0.00	0.00	0.00
# 35	18104		22.87	3.28	0.00	0.00	0.00	0.00
# 36	18105		34.15	6.86	0.00	0.00	0.00	0.00

APPENDIX V
TABLE 11

	CODE#	NAME OF MUNICIPALITY	NET MUN COLL'N COST PER TON	NET MUN DISP COST PER TON	NET RECOVERY REVENUE/TON	NET IND DISP REV PER TON	MUN COL'N COST PER CUBIC YAR	MUN LANDFILL COST PER CU YD
#	37	17401	18.61	5.59	0.00	0.00	0.00	0.00
#	38	18402	20.97	11.23	0.00	0.00	0.00	0.00
#	39	18403	19.04	0.00	0.00	0.00	0.00	0.00
#	40	18404	10.70	0.00	0.00	0.00	0.00	0.00
#	41	18405	20.48	0.00	0.00	0.00	0.00	0.00
#	42	20000	0.00	2.33	0.00	0.00	0.00	0.00
#	43	20101	19.11	0.00	0.00	0.00	0.00	0.00
#	44	20102	22.80	0.00	0.00	0.00	0.00	0.00
#	45	20601	32.88	0.00	0.00	0.00	0.00	0.00
#	46	20603	24.02	0.00	0.00	0.00	0.00	0.00
#	47	20604	18.51	0.00	0.00	0.00	0.00	0.00
#	48	20609	28.17	0.00	0.00	0.00	0.00	0.00
#	49	21401	9.44	0.00	0.00	0.00	0.00	0.00
#	50	23402	26.07	0.00	0.00	0.00	0.00	0.00
#	51	23404	19.55	0.00	0.00	0.00	0.00	0.00
#	52	23405	0.00	10.31	0.00	0.00	0.00	0.00
#	53	23406	20.19	0.00	0.00	0.00	0.00	0.00
#	54	25000	0.00	6.11	0.00	0.00	0.00	0.00
#	55	25101	19.93	0.00	0.00	0.00	0.00	0.00
#	56	25102	20.69	0.00	0.00	0.00	0.00	0.00
#	57	25103	13.63	0.00	0.00	0.00	0.00	0.00
#	58	25603	13.53	0.00	0.00	0.00	0.00	0.00
#	59	25604	16.23	0.00	0.00	0.00	0.00	0.00
#	60	27401	28.95	0.00	0.00	0.00	0.00	0.00
#	61	27402	28.34	0.00	0.00	0.00	0.00	0.00
#	62	27403	29.62	0.00	0.00	0.00	0.00	0.00
#	63	27404	28.69	0.00	0.00	0.00	0.00	0.00
#	64	27405	17.26	21.80	0.00	0.00	0.00	0.00
#	65	27406	34.35	0.00	0.00	0.00	0.00	0.00
#	66	27407	36.05	0.00	0.00	0.00	0.00	0.00
#	67	27601	22.89	5.29	0.00	0.00	0.00	0.00
#	68	27603	8.97	0.00	0.00	0.00	0.00	0.00
#	69	33401	0.00	4.67	0.00	0.00	0.00	0.00
#	70	33403	24.03	0.00	0.00	0.00	0.00	0.00
#	71	37000	0.00	8.74	0.00	0.00	0.00	0.00
#	72	37101	16.00	0.00	0.00	0.00	0.00	0.00
#	73	37401	0.00	9.70	0.00	0.00	0.00	0.00
#	74	40101	15.21	4.55	0.00	0.00	0.00	0.00
#	75	43401	26.79	0.00	0.00	0.00	0.00	0.00
#	76	44101	25.99	0.00	0.00	0.00	0.00	0.00
#	77	45000	0.00	1.53	0.00	0.00	0.00	0.00
#	78	45101	46.67	0.00	0.00	0.00	0.00	0.00
#	79	45406	31.09	0.00	0.00	0.00	0.00	0.00
#	80	45612	32.21	0.00	0.00	0.00	0.00	0.00
#	81	46101	27.11	14.46	0.00	0.00	0.00	0.00
#	82	46607	24.01	7.57	0.00	0.00	0.00	0.00
#	83	47101	37.02	1.50	0.00	0.00	0.00	0.00
#	84	51101	30.28	0.00	0.00	0.00	0.00	0.00

APPENDIX V
TABLE 12

	CODE#	NAME OF MUNICIPALITY	NET MUN COLL'N COST PER TON	NET MUN DISP COST PER TON	NET RECOVERY REVENUE/TON	NET IND DISP REV PER TON	MUN COL'N COST PER CUBIC YAR	MUN LANDFILL COST PER CU YD
# 85	51301		23.40	0.00	0.00	0.00	0.00	0.00
# 86	51615		13.29	0.00	0.00	0.00	0.00	0.00
# 87	53101		31.05	5.53	0.00	0.00	0.00	0.00
# 88	53406		39.75	0.00	0.00	0.00	0.00	0.00
# 89	54101		23.48	6.69	0.00	0.00	0.00	0.00
# 90	54608		22.29	5.06	0.00	0.00	0.00	0.00
# 91	55301		0.00	10.56	0.00	0.00	0.00	0.00
# 92	56101		23.16	7.65	0.00	0.00	0.00	0.00
# 93	57605		19.68	11.27	0.00	0.00	0.00	0.00
# 94	59402		0.00	5.75	0.00	0.00	0.00	0.00
# 95	61403		0.00	18.38	0.00	0.00	0.00	0.00
# 96	61404		0.00	8.09	0.00	0.00	0.00	0.00
# 97	61609		0.00	5.48	0.00	0.00	0.00	0.00
# 98	65101		26.88	11.64	0.00	0.00	0.00	0.00
# 99	66101		14.92	5.26	0.00	0.00	0.00	0.00
# 100	69101		33.94	8.00	0.00	0.00	0.00	0.00
# 101	70101		15.90	6.05	0.00	0.00	0.00	0.00
# 102	70102		14.11	6.16	0.00	0.00	0.00	0.00
# 103	70403		12.22	9.82	0.00	0.00	0.00	0.00
# 104	70404		11.41	0.00	0.00	0.00	0.00	0.00
# 105	70602		9.01	0.00	0.00	0.00	0.00	0.00
# 106	70605		20.26	0.00	0.00	0.00	0.00	0.00
# 107	71101		24.79	9.34	0.00	0.00	0.00	0.00
# 108	72401		14.40	10.83	0.00	0.00	0.00	0.00
# 109	75101		14.54	8.31	0.00	0.00	0.00	0.00
# 110	80101		30.70	4.60	0.00	0.00	0.00	0.00
# 111	80404		23.89	6.09	0.00	0.00	0.00	0.00
# 112	81101		34.80	6.04	0.00	0.00	0.00	0.00
# 113	81404		39.06	2.52	0.00	0.00	0.00	0.00
# 114	82403		49.86	8.48	0.00	0.00	0.00	0.00
# 115	85101		17.66	3.57	0.00	0.00	0.00	0.00
# 116	87401		0.00	6.29	0.00	0.00	0.00	0.00
# 117	89101		30.78	0.00	0.00	0.00	0.00	0.00
# 118	90405		22.11	2.87	0.00	0.00	0.00	0.00
		TOTALS:	27.57	5.94	0.00	0.00	0.00	0.00

APPENDIX VI

MUNICIPAL COST STATISTICS AND PROJECTED NET COST SAVINGS

MUNICIPAL STATISTICS

The statistics shown on Table 1 following were developed based on data provided by the department of Finance and Economics, from a utility computer program developed for the consultants during the design phase of the costing system. The data on collection and disposal costs included in the program is extracted directly from the Municipal Finance Branch records for 1977.

Highlights of the summary analysis prepared for municipalities of more than 10,000 population are as follows.

- 107, or 21%, of the municipalities operating a collection service expend 94% of the collection cost dollars.
- 73, or 12%, of the municipalities operating a disposal service expend 90% of the disposal cost dollars.
- In total, 148 or 18% of the municipalities have more than 10,000 population and spend 93% of the solid waste costs.

Thus, for wider implementation of the costing system on a full-scale basis, 148 major municipalities will need to be approached to cover 93% of the total cost. If 60% of these major municipalities (10,000 population plus) respond to the initial request for data, detailed information covering 56% of the provincial cost will be available.

If the other 688 smaller municipalities respond at a 70% success level this will add an additional 5% coverage of cost and tonnage data, and bring total coverage of the system up to the 60% level for the province.

We recommend that the input be requested from all major municipalities (10,000 population plus) in 1980 for 1979 data.

MUNICIPAL STATISTICS

	Population		
	>10,000	<10,000	TOTAL
Collection Statistics			
Municipalities operating a Collection Service	107	402	509
Collection Cost	$ 62,928,240	$3,877,322	$ 66,805,562
% of total:			
- Municipalities	21%	79%	100%
- Collection Cost	94%	6%	100%
Disposal Statistics			
Municipalities operating a Disposal Service	73	514	587
Disposal Cost	$ 38,362,083	$4,052,018	$ 42,414,101
% of total:			
- Municipalities	12%	88%	100%
- Disposal Cost	90%	10%	100%
Total Statistics			
Total	148	688	836
Total Cost	$101,290,323	$7,929,340	$109,219,663
% of total:			
- Municipalities	17%	83%	100%
_ Total Cost	93%	7%	100%

PROJECTED PROVINCIAL COST SAVINGS

Based on our analysis of cost and revenue differentials in the nine sample municipalities, projections were made using the summarized provincial cost data available for 1977. Estimated net cost savings were calculated for the following items:

- Collection costs in total.
- Collection labour costs.
- Collection equipment costs.
- Disposal costs.
- Disposal revenues.

It is recognized that the potential savings estimates are pure projections based on a small sample. However, we believe that the figures prepared represent a realistic target range of net cost reduction that should be achieved if the cost accounting system is implemented for major municipalities within the Province of Ontario. Attainment of the savings will depend heavily on the degree of follow-up effort that is applied by Waste Management Branch staff once the system is implemented, i.e., by working closely with municipal staff and by suggesting operating efficiency improvements branch staff should be able to encourage effective cost reduction or revenue generation activity within the municipalities.

1. Collection Cost Savings Could be up to $3.6MM per Annum

   In the case of total collection costs, the average cost per ton ($30.25) was calculated for five sample municipalities with populations over 10,000 as shown on Table 1 following. This average cost level was then applied to those municipalities with an above average cost per ton. The cost difference was calculated in total and applied as a percentage of the total collection costs in this sample. This gave a projected cost saving of 5.44% of collection costs. This percentage was then applied to the total provincial 1977 collection cost (plus inflation of 6%) for municipalities of more than 10,000 population. The result was a projected annual potential cost saving of $3,628M in 1978 dollar terms.

2. Municipal Collection Labour Cost Savings Could be up to $3.6MM per Annum

   In this example, a comparison of collection labour costs was made for three municipalities operating their own services. In our analysis of the provincial reports, we concluded that the differences in these labour costs was due principally to the frequency of collection. Thus, we consider it reasonable that the two higher cost municipalities should be able to reduce costs to the lower cost level ($17.46) of the third municipality. A cost saving percentage of 18.28% for the sample municipalities was then applied to the estimated labour cost element of the total provincial municipal labour cost. The estimated potential savings were then calculated out to be $3,601M as shown on Table 2, following. These savings would form part of the savings mentioned in 1 above.

3. Municipal Collection Vehicle Cost Savings Could be up to $0.4MM Per Annum

As with the labour cost element mentioned above, the average lower cost level for equipment cost in two sample municipalities was applied to the tonnage at a third higher cost municipality. The savings percentage (5.91%) was then applied to the estimated total provincial cost for equipment, and a potential saving of $378M per annum was estimated (see Table 3, following, for details).

4. Landfill Cost Savings Could Amount to $2.9MM per Annum

For landfill costs, four sample municipalities were reviewed, and as with collection costs (sub-sectional), the higher cost municipalities were brought in line. The potential saving percentage of 14.03% was then applied to the total provincial landfill cost excluding the Metropolitan area. This area was excluded because of the complexity of operating facilities which made it impractical to estimate potential cost savings.

Based on the calculations a potential provincial cost saving of $2,911MM per annum for landfill costs was calculated.

5. Increased Landfill Revenues of $3.2MM Should be Sought

Of the four municipalities included in this analysis, only one was recovering the landfill cost per ton by realistic charges to private users (large region near Toronto). For the other three municipalities a calculation of the amount of under-recovered cost relating to private users was calculated (100% - 68.49% = 31.51%). This under-recovered cost factor was then applied to the estimated total provincial cost relating to the non-residential tonnage estimate. Potential "under-recovered" costs or alternately "additional revenues" were estimated to be $3,240M.

POTENTIAL COLLECTION COST SAVINGS

Municipality	Collection Cost	Tons Collected	Collection Cost Per Ton (Gross)	Average Cost Per Ton	Cost Reduction Per Ton	Total Cost Reduction
Large South Western City	3,065,343	97,220	31.54	30.25	1.29	125,414
Large Metropolitan Suburb	4,935,222	153,570	32.14	30.25	1.89	290,247
Large Northern City	1,135,316	29,075	39.04	30.25	8.79	255,589
Large South Western City	1,171,365	39,438	29.70	-	-	-
Large Suburb near Toronto	2,031,988	88,560	22,94	-	-	-
Total	$12,339,234	$407,863				$ 671,230
Average			$30.25			
Cost Reduction % of Total Cost						5.44%

- o Total collection cost of municipalities over 10,000 population (including 6% inflation of 1977 dollars) $66,703,934
- o Potential cost reduction of 5.44% $ 3,628,561

APPENDIX VI
SECTION B
TABLE 1

POTENTIAL COLLECTION COST SAVINGS

MUNICIPAL LABOUR COSTS

Municipality	Collection Labour Costs	Tons Collected	Collection Cost Per Ton	Lower Cost Per Ton	Cost Reduction Per Ton	Total Cost Reduction
Large South Western City	1,697,461	97,220	17.46	-	-	-
Large Metropolitan Suburb	2,948,856	125,270	23.54	17.46	6.08	761,642
Large Northern City	679,550	26,775	25.38	17.46	7.92	212,058
	5,325,867					973,700

- Potential Cost reduction % of total labour cost — 18.28%

- Collection Labour Cost % of total collection costs for 3 sample municipalities

  $= \frac{5,325,867}{9,016,562} = 59.07\%$

  (Assume 50% of collection costs are for municipal operations)

- 50% of collection costs for municipalities over 10,000 population (including inflation of 6%) — $33,351,967

- 59% of municipal collection costs = labour element — $19,701,006

- Potential cost reduction of 18.28% of labour costs — $ 3,601,343

APPENDIX VI
SECTION B
TABLE 2

POTENTIAL COLLECTION COST SAVINGS

EQUIPMENT OPERATING AND REPAIR COSTS

Municipality	Equipment Costs	Tons Collected	Equip. Cost Per Ton	Average Cost of Lower Cost Municipalities	Cost Reduction Per Ton	Total Cost Reduction
Large South Western City	735,955	97,220	7.57	6.52	1.05	102,081
Large Metropolitan Suburb	814,255	125,270	6.50	-	-	-
Large Northern City	177,518	26,775	6.63	-	-	-
Sub Total	991,773	152,045	6.52			-
Grand Total	$1,727,728					$102,081

- Potential Cost reduction % of total equipment cost 5.91%
- Equipment cost % of total cost for sample municipalities

$$= \frac{1,727,728}{9,016,562} = 19.16\%$$

- 19.16% of municipal collection cost ($33,351,967) = Equipment Element $6,390,237
- Potential cost reduction of 5.91% of equipment costs $ 377,663

APPENDIX VI
SECTION B
TABLE 3

APPENDIX VI
SECTION B
TABLE 4

POTENTIAL LANDFILL COST SAVINGS

Municipality	Landfill Cost $	Tons Landfilled	Landfill Cost Per Ton $	Average Cost Per Ton $	Cost Reduction Per Ton $	Total Cost Reduction $
Large South Western City	1,685,454	193,897	8.69	6.39	2.30	445,963
Large Northern Region	294,400	81,700	3.60	-	-	-
Large South Western City	706,372	78,968	8.95	6.39	2.56	202,158
Large Region near Toronto	1,934,778	368,796	5.25	-	-	-
Total	$4,621,006	$723,361				$648,121
Average			$6.39			
Cost Reduction % of Total Cost						14.03%

- Total landfill cost of municipalities over 10,000 population excluding metropolitan area (including 6% inflation to 1977 dollars) $20,755,057
- Potential cost reduction of 14.03% $ 2,911,001

POTENTIAL REVENUE INCREASE

Municipality	Tonnage Landfilled Total	Tonnage Landfilled Non Residential	Landfill Cost Per Ton $	Revenue Adjusted $	Revenue Actual $	Increased Revenue $
Large South Western City	193,897	96,677	8.69	840,123	451,417	+ 388,706
Large Northern City	81,700	52,625	3.60	189,450	Ø	+ 189,450
Large South Western City	78,968	35,129	8.95	314,405	57,492	+ 256,913
Large Region near Toronto	368,796	233,532	5.25	1,226,043	1,302,812	- 76,769
	723,361	382,834		$2,570,021	$1,811,721	$ 758,300
		(52.92%)			(70.5%)	

• Total landfill cost large municipalities excluding metropolitan area	$20,755,057
• 52.92% pertaining to non-residential tonnage	$10,983,576
• 70.5% probable current revenue level	$ 7,743,421
• Potential increased revenue from non-residential tonnage	$ 3,240,155

APPENDIX VI
SECTION B
TABLE 5